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C. R. Casson I

HOT TENSILE TESTING WITH MINIATURE TEST PIECES.

By G. T. HARRIS, B.A.*

IN the course of an investigation on an aero-engine exhaust valve, it was found necessary to carry out a hot tensile test using a very limited quantity of material. As the normal size of hot tensile test-piece requires about 7 in. of 1-in. diameter material, test equipment was built up to deal with test pieces requiring only 1½ in. of ⅞-in. diameter material. The testing machine used was the standard worm-gear long-base Hounsfield Tensometer, which was found very convenient for the purpose. The No. 12 Tensometer test-piece was used, but the ends, instead of being headed, were screwed for ½ in. with ¼ in. Whitworth threads, so providing five threads for gripping in the shackles. The overall length of the test-piece was 1·2 in., the parallel portion being 0·632 in. long by 0·1785 in. diameter, thus corresponding to a cross-sectional area of $\frac{1}{20}$ sq. in. and having an $\frac{L}{\sqrt{A}}$ value of 4, as for the standard 0·564 in. diameter, 2 in. gauge-length test-piece. The test-piece was screwed into special adaptors made from austenitic heat-resisting steel. These were ½-in. in diameter by 4 in. long, and had headed ends to fit into the No. 17/18 Tensometer chucks. The screwed holes in which the test-piece was fitted were accurately machined to ensure that they were both axial and central, in order to ensure axial loading.

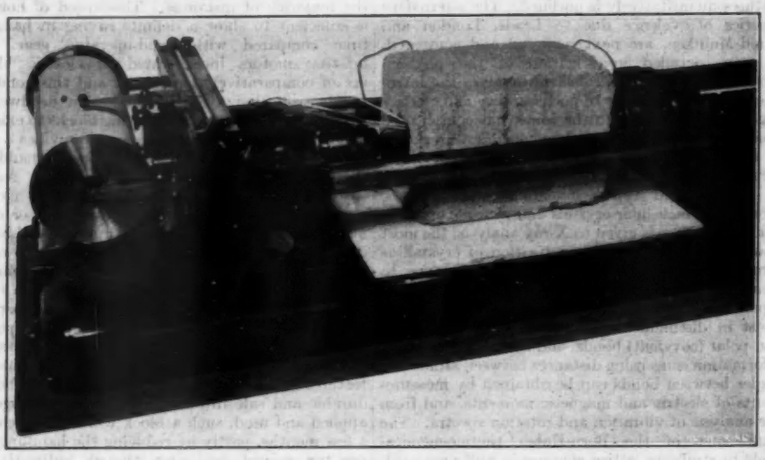


FIG. 1.

The electric furnace for heating the test-piece had a total resistance of 4 ohms and was made by winding about 8 ft. of 20 gauge Nichrome wire on a steel tube insulated by layers of asbestos paper. The tube was cut from a standard 1 in. diameter, ⅛ in. wall thickness, pyrometer sheath, made from austenitic heat-resisting steel. The windings were spaced closer at the ends to allow for additional heat losses there, and as the furnace tube was 5 in. long, or eight times the parallel portion of the test piece, the temperature distribution was sufficiently uniform over this portion without taking any special precautions. The furnace tube was inserted in a hole drilled through an insulating brick, 6 in. by 4 in. by 3½ in., which afforded excellent thermal insulation with the minimum constructional difficulty. Such bricks are quite strong mechanically and unless subjected to rough use it is unnecessary to provide a metal casing, which could, of course, be simply made from sheet brass, aluminium or stainless steel. Fig. 1 shows the general arrangement of the apparatus, and Fig. 2 illustrates the test-piece and heat-resisting shackles.

Temperature measurements were made by three platinum platinum-rhodium thermocouples of 0·3 mm. diameter wire encased in fine silica twin-bore insulators. These were attached by fine platinum wires to the middle and ends of the test-piece. During the heating up period, which took about an hour to 800 deg. C., using a current of about 8 amperes (250 watts), a considerable temperature difference existed along the test-piece, but when a steady state was attained this improved to about 2 deg. C. variation over the gauge-length. A soaking time of about half an hour was allowed after the required temperature had been attained. Temperature control was simple, as the furnace was quick in response; the current was adjusted to be slightly higher than that necessary to maintain the required temperature and the circuit was broken at appropriate intervals for a few seconds. Control to within about ±1 deg. C. could be attained throughout the test period, which, for most tests, was of the order of 20 minutes.

As the rate of straining is a very important factor in such tests, provision was made for this to be kept constant by turning the loading handle at a constant known speed. This can be done most simply by hand; an electric motor may be used, but if so it must be of ample power or its speed will vary appreciably as the load increases. There is no standard in this country, but a fairly common rate of straining is $\frac{1}{16}$ in. per minute on a 2½-in. parallel test-piece, which is equivalent to 0·028 in. per in. per min. On the small test-piece this amounts to one revolution of the loading shaft in 11½ seconds. The elongation and reduction of area were measured by the usual gauges provided for Tensometer test-pieces.

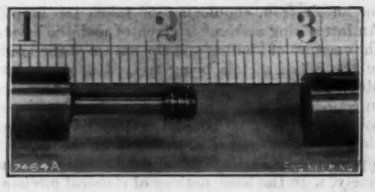


FIG. 2.

TABLE I.—*Hot Tensile Tests on Large and Small Test-Pieces.*

Rate of straining, 0·028 in. per in. per min.

Steel.	Temperature of Test.	Size of Test-piece.	Maximum Stress. Tons per sq. in.	Elongation Per cent. on $\frac{L}{\sqrt{A}} = 4$.	Reduction of Area. Per cent.
A	800 deg. C.	Small	15·2	41	56
A	800 deg. C.	Large	15·5	57	61
B	700 deg. C.	Small	7·9	64	92
B	700 deg. C.	Large	7·7	95	95
B	600 deg. C.	Small	18·9	69	93
B	600 deg. C.	Large	19·3	75	93

In order to determine what reliance could be placed on the results, tests were made on large and small test pieces cut from the same bar of various materials. Some of the results are given in Table I. The large test piece was the standard 2 in. gauge length, 0·564 in. diameter specimen. It will be seen that the method gives reliable results for the maximum stress, the figures obtained not differing by more than 2½ per cent. from those on standard size test-pieces. The reductions of area are also fairly consistent, with a maximum variation of 8 per cent., tending to be lower for the small test-pieces. The elongations are much more variable, in one of the cases cited being over 30 per cent. low. Part of the difference may be accounted for by the increased stiffening at the ends of the parallel portion due to the very sharp fillet radius of $\frac{1}{64}$ in. This would not account for such a difference as 30 per cent., and although variations in temperature distribution during extension might have some effect, it is evident that too much reliance should not be placed on the elongation figures. In view, however, of the small quantity of material required, and incidentally the lower cost of preparation of test-pieces and equipment, the fact that reliable figures for the maximum stress and percentage reduction of area can be obtained by this method suggests that it might be more widely used with success.

* Research Department, Messrs. William Jessop and Sons, Ltd., Sheffield.

LITERATURE.

Electrical Contacts. By G. WINDRED. London: Macmillan and Company. [Price 16*s.*]

THE number and quality of reference and text-books on the design of transformers and rotating electrical machinery has been maintained at an adequate level for the past 20 years, but, of books on the principles of design of the equally-important switching and control gear, the choice is still small and the standard relatively low. In his preface to the present work, the author states that his object has been to give an account of the theory and application of electrical contacts in a form that will be acceptable for reference purposes in connection with both electrical design and research; but, unfortunately, he has not presented his material in a form which is useful to contact designers; and research workers will probably prefer to consult the original papers, rather than the author's abstracts.

The first chapter gives a simple account of the theory of contact phenomena, based principally on the considerable amount of work which has been done in Germany; the summary of the researches of Contius at Dresden is particularly valuable, since it has not been published in the technical Press. The weakness of the chapter is that no indication is given of the practical application of the theory to present-day design; for example, the coherer effect is described at length, but there is no guide to the type of contact in which the effect is important. This is a serious omission, since the subject ranges from relay contacts carrying a few milliamperes to switch contacts having a one-second rating of 44,000 amperes. The account of joints between conductors would have been more useful if some design rules had been included; for instance, the rules for estimating the temperature rise of 'bus bars and joints; and it would have been preferable to describe the use of silver line contacts, applied by the mercury cementation process to 'bus bar joints, rather than to discuss at length magnesium 'bus bars, which are seldom used.

The design of modern switchgear contacts is almost entirely determined by the requirements of B.S.S. No. 116-1937, which specifies the maximum temperature rise that may be attained due to the heating effects of load current, and also the short-circuit current making and breaking operations that a circuit breaker must carry out without sustaining damage. The chapter on switch contacts in the present volume does not mention the requirements of B.S.S. No. 116, so the contents are of little value to designers, and may be misleading to the student reader. The author refers to short circuits as though both the magnitude and duration of the short-circuit

current were unknown; actually, of course, all reputable switchgear is designed nowadays to have a definite breaking capacity (r.m.s. kilo-amperes), and making capacity (peak kilo-amperes), and must carry the rated breaking current for one second. Type tests are almost invariably carried out to prove that switchgear will meet the B.S.S. requirements for a particular rating. The book is not up to date, therefore, in suggesting that deformation of contact structures may take place under short-circuit conditions; the stresses produced under these conditions are known, and allowance for them is part of the design. The breaker shown in Fig. 25 is now obsolete, short-circuit experience having shown that plain-break circuit breakers are quite unsuitable for a rating of 250,000 kVA at 20 kV.

The simpler aspects of circuit theory are adequately dealt with, but the calculation of rate of rise of recovery voltage is omitted, although this is generally recognised as being one of the principal factors affecting short-circuit interruption. In dealing with arcs, the author might have made it clearer that the properties of arcs burning in still air, which he describes, are very different from those of switching arcs, which are generally subject to intense cooling action from the arc-chute walls, switch oil, or air blast. The most useful chapter to the designer is that on the subject of contact materials, which includes the tabulated physical properties of all the important contact metals and alloys. A large bibliography is appended to each chapter (one has 140 references), but there is no guidance regarding the relative importance of the papers. It might have been better to select a few outstanding papers for immediate reference, leaving the remainder to be sought in *Science Abstracts*. The book will probably interest the general reader, but a designers' reference book on contacts still remains to be written.

Electronic Structure and Chemical Binding: with Special Reference to Inorganic Chemistry. By PROFESSOR O. K. RICE. London: McGraw-Hill Publishing Company. [Price 33s.]

NOWHERE, perhaps, have the results of physicists' investigations into the problems of atomic structure, during the past 45 years, had a more direct and profitable application than to chemistry. It is now established that the chemical nature of an atom is determined by its extra nuclear charge, this charge consisting of individual electrons, in number equal to the atomic number, which specifies the location of the corresponding element in the periodic table. In the neutral atom, this extra nuclear charge balances the resultant positive charge on the nucleus. The function of the nucleus is to maintain the electrons in an ordered arrangement within the frontiers of the atom. On the character of this electronic grouping in response to the central charge must depend the properties of the atom. Chemical combination results from the interlocking of atoms to form molecules, and involves a more or less profound readjustment of the electronic grouping between the atoms concerned. When the configuration of the structural units within the molecule can be ascertained, it should be possible to deduce therefrom all the chemical and physical attributes of the molecule. This objective is far from having been achieved, but Professor Rice, in this book, indicates the considerable progress that has already been made in correlating structure with properties in the inorganic field.

The book opens with a historical sketch of the development of the quantitative groundwork of classical chemistry, which led to the determination of atomic weights and the establishment of the periodic classification. The next section, comprising seven chapters, summarises the essential physical basis. The pioneer experiments of Thomson, of Millikan, and of Rutherford are first reviewed. The wave and corpuscle duality is then examined, the former aspect predominating when propagation is concerned, and the latter when transfers of energy to individual electrons and atoms are involved. An outline of the elementary quantum theory follows, in which its essential features are brought out by treating particular examples, thus enabling the results of wave mechanics to be grasped while avoiding complicated mathematical developments. The simplest of atoms, that of hydrogen, is then considered in sufficient detail to show how its energy levels can be calculated theoretically and verified spectroscopically. The effects of electron spin, angular momentum and magnetic moment are described, together with the Stern-Gerlach technique. Despite the quite disproportionate increase in difficulty in dealing with many-electron atoms, certain comparatively simple assumptions—such, for example, as the Pauli exclusion principle—enable a series of electronic structures to be derived, in terms of which the observed spectral data can be interpreted.

The more exclusive concentration upon chemical topics begins in Chapter IX, with a discussion of the formation of compounds and of the manner in which molecular energy levels can be deduced from molecular spectra. The method of deriving the dissociation energy of molecules from their band spectra is also considered, together with the rotation and vibration of polyatomic molecules. The reference, on page 114, to the moment of inertia of two nuclei "about their centre of gravity" needs amending. The simplest example of a non-polar molecule is that of hydrogen, and the impressive manner in which wave mechanics interprets its features quantitatively is outlined. The alternative theories of valence due to Lewis, London and Hund-Mulliken, are next reviewed and compared. A more detailed investigation of the physical properties of the chemical bond involves the introduction of the concepts of polarisability and electronegativity, and leads to the somewhat complicated procedures for determining bond energies. A sketch of the nature of the solid state, in Chapter XIII, serves to introduce the more detailed consideration of special solid types, including ionic crystals, atomic and molecular crystals and metallic crystals. Due prominence is given to X-ray analysis, the most powerful means for the investigation of crystalline structures in that it serves to fix the lattice type, to locate the constituent atoms and to determine their separation. It is shown how such information can assist in distinguishing between polar (ionic) and non-polar (covalent) bonds, and how supplementary information concerning distances between atoms and angles between bonds can be obtained by measurements of electric and magnetic moments, and from the analysis of vibration and rotation spectra. The significance of the Born-Haber thermochemical cycle in studying lattice energies is well presented. A remark on page 275, suggesting that an eigen function is competent to provide a local habitation for an electron, should not be taken too literally! An interesting account is given of metallic crystals, the energies of binding and the nature of the binding in the alkali metals being treated in some detail. Much greater theoretical difficulties are encountered in connection with liquids than with either gases or solids, and the final chapter is devoted to a discussion of the structure of water and the nature of aqueous solution. Four appendices deal, respectively, with the basic notions of classical mechanics, the principles of thermodynamical equilibrium, electric forces and geometrical crystallography. A fifth appendix contains a useful list of general references.

The text makes attractive reading despite the rather frequent occurrence of split infinitives of the irritating kind, and will appeal to those whose main interests are not exclusively chemical. Without entering into mathematical detail, a generally successful attempt is made to provide a concrete picture of the results of such analysis. Stress is laid primarily on the theoretical interpretation of experimental findings, the experimental methods themselves receiving only cursory consideration. Evidence of the essential validity of the fundamental physical concepts now current is afforded by the many instances of striking agreement between deductions from comparatively simple and straightforward assumptions based upon them and the results of experiment. This does not imply, of course, that even the most highly developed theory is capable, as yet, of covering quantitatively the whole of the multifarious data of chemistry, or even of inorganic chemistry. Outstanding discrepancies still persist, to provide the problems of the future.

ELECTRIC HOISTING BLOCKS.

By E. G. FIEGEHEN, M.I.Mech.E.

SINCE electric hoisting blocks provide a most convenient and very flexible means of securing the advantages and economies of power operation in the handling of small loads, some account of modern practice in the design and construction of such appliances may be of interest in these days of intensive production. It has not been possible to deal with the products of all the firms concerned, wholly or partly, in this branch of engineering, but the illustrations given in Figs. 1 to 15, opposite, and on Plates VIII and IX, show the products of half-a-dozen representative manufacturers.

The usual range of capacities is from 3 cwt. to 5 tons, the most popular sizes being from 5 cwt. to 1 ton. Occasionally, hoisting blocks having a capacity of as much as 10 tons are made. A maximum lifting range of 20 ft. is sufficient for most applications, and, since most of the lifts in service will be appreciably less than this, a hoisting speed of 20 ft. per minute is found to be adequate in the majority of instances. This speed of hoisting is sufficient to show a definite saving in handling time compared with hand-operated gear. The hoisting motors incorporated in electric blocks are of comparatively small size, and this conduces to compact design and reduction in deadweight. The application of electric hoisting blocks to existing hand-operated cranes and runways provides a convenient transitional stage until the demands of the service justify the installation of regular electric cranes or transporters. Since an electric block only requires suspension from a jib or other member and connection to the supply mains before it is ready for service, it may be transferred easily and quickly, by unskilled labour, from one situation to another as the need arises, say, from one swing jib in a shop aisle to the next, and the user can thus secure most of the advantages of power-hoisting equipment at a small capital outlay. Modern electric hoisting blocks incorporate the best features of electric-crane practice and are efficient, durable and safe in operation. When intelligently applied and used, such a block will save its cost in a few months, partly by reducing the handling cost per ton moved, and also, though indirectly, by speeding up related services.

As regards construction, it will be clear that the members which transmit the tensile load, from the hook to the block suspension, should be of steel and designed so that the stress is low, the transmission as direct as possible, and sufficiently stiff to resist deflection under load to ensure that the alignment of the connected parts and bearings is not disturbed. Typical methods are shown in Fig. 1 and Fig. 6, Plate VIII, the former illustrating separate end-plates stiffened by struts, with two stout bars connecting them and carrying the suspension shackle and the equalising pulley, respectively. In Fig. 6, the tensile stress is transmitted through a single casting in which the hoist barrel is mounted in ball bearings. It is generally recognised that direct-current supply is the most suitable for crane operation, and, when this is available, it should be employed, since series-wound motors of the type generally used give a lifting speed which is inversely proportional to the load. Hoisting blocks can, however, be operated quite satisfactorily on two-phase or three-phase current supply, although the motors available are less flexible from the point of view of speed adjustment. Single-phase motors, generally of the induction-repulsion type, can also be used, though on the whole they are less satisfactory for this particular purpose than three-phase or direct-current motors. The totally-enclosed motor is the type normally employed, and is rated for a temperature rise of 90 deg. F. after a run of half an hour at full load. Some firms test the completed block under continuous hoisting and lowering of the rated load for a period of half an hour to check the temperature rise of the motor.

The motor is mounted on the block in several different ways. In some blocks a motor of a normal industrial type, with feet on the casing, is bolted to

ELECTRIC HOISTING BLOCKS.

(*For Description, see Page* 102.)

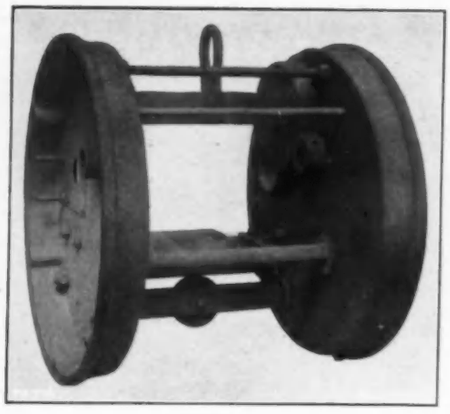


FIG. 1.

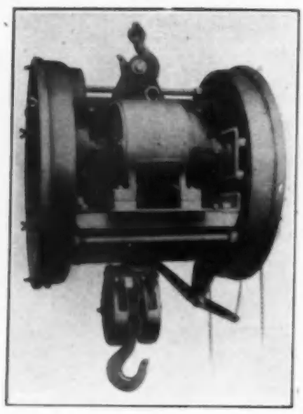


FIG. 2.

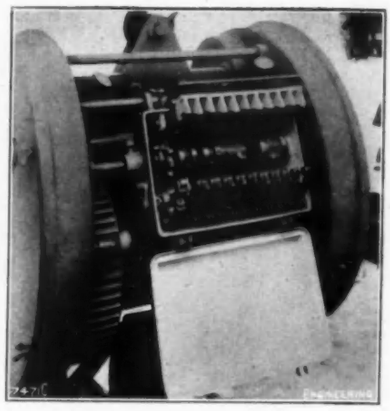


FIG. 3.

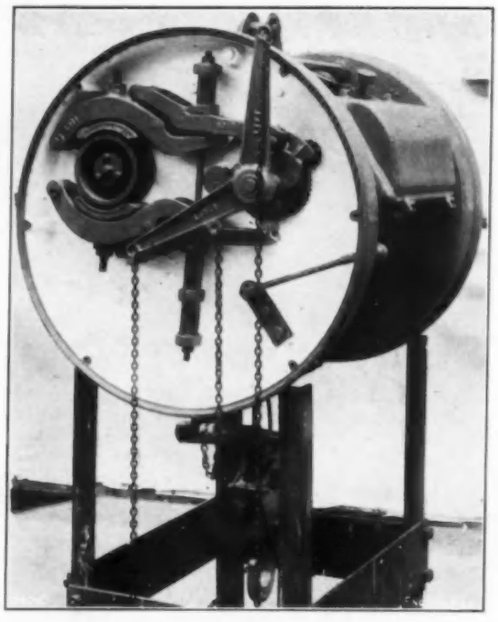
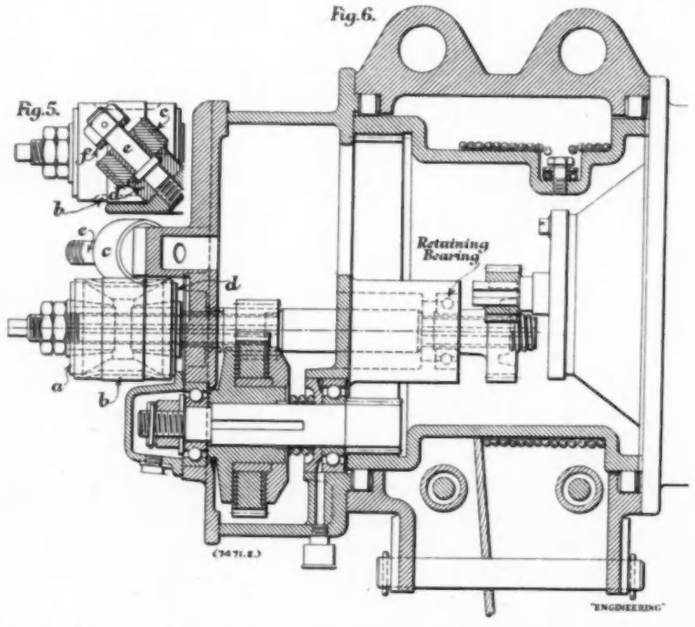


FIG. 4.

FIGS. 1 TO 4. DETAILS OF HOISTING BLOCK; MESSRS. S. H. HEYWOOD AND COMPANY, LIMITED.

Fig.6.



FIGS. 5 AND 6. SELF-SUSTAINING HOISTING BLOCK; MESSRS. MATTERSON, LIMITED.

Fig.7.

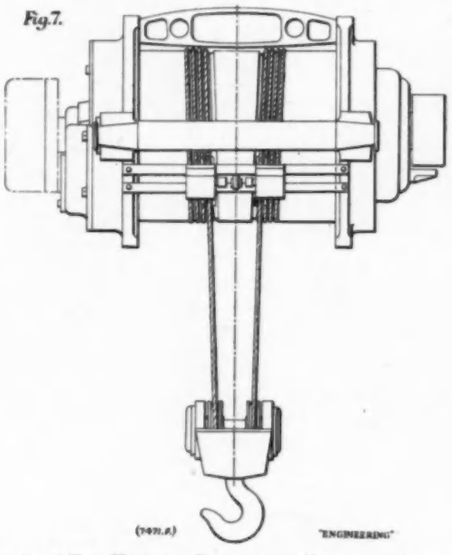


FIG. 7. 4-TON HOISTING BLOCK WITH ELECTROMAGNETIC BRAKE; MESSRS. MATTERSON, LIMITED.

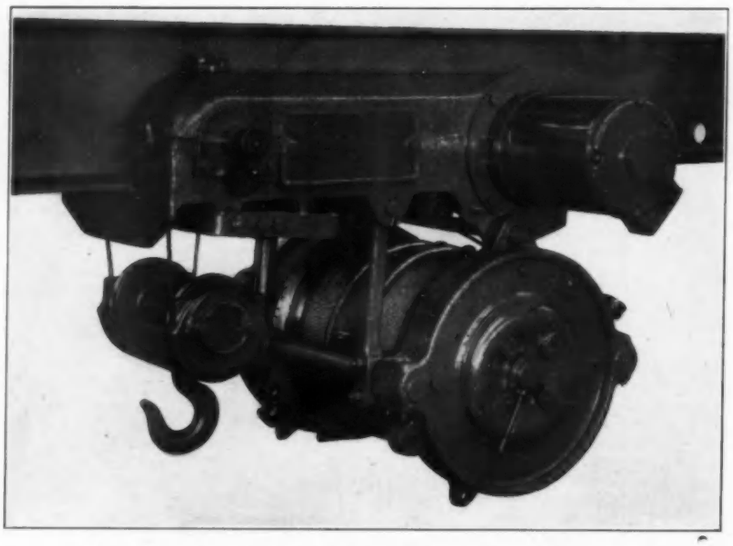


FIG. 8. SIDE-LIFT RUNWAY HOISTING BLOCK; MESSRS. MATTERSON, LIMITED.

(*Between pages* 102 *and* 103.)

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(*For Description, see Page* 102).

FIG. 9. DIRECT LIFT RUNWAY BLOCK; MESSRS. PATERSON HUGHES ENGINEERING CO., LTD.

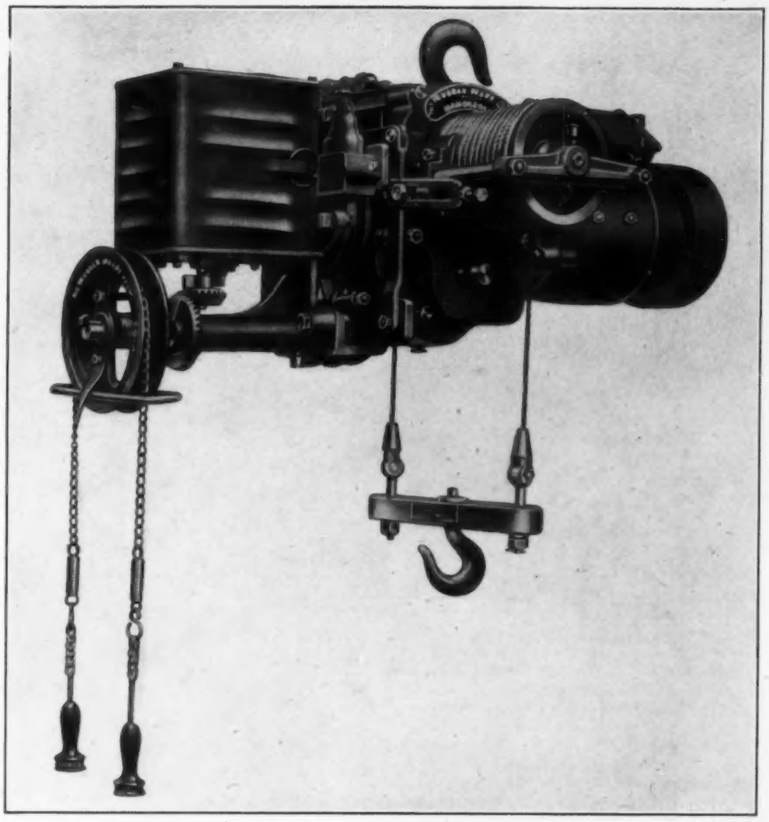

FIG. 10. HOISTING BLOCK WITH CHAIN CONTROL; MESSRS. THE VAUGHAN CRANE COMPANY, LIMITED.

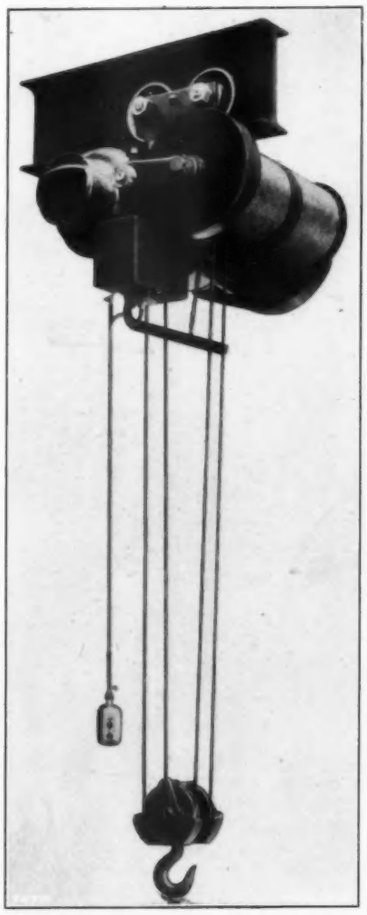

FIG. 11. HOISTING BLOCK WITH PENDANT CONTROL; MESSRS. HERBERT MORRIS, LIMITED.

FIG. 12. HOISTING BLOCK ON TRANSPORTER CARRIAGE; MESSRS. THE VAUGHAN CRANE COMPANY, LIMITED.

(*Between pages* 102 *and* 103).

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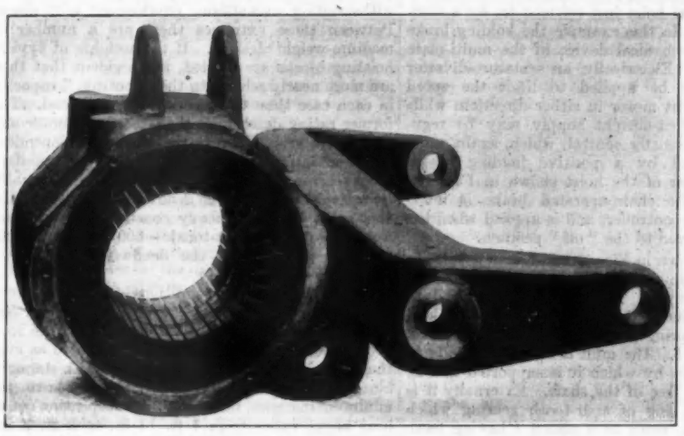


FIG. 13. MOTOR STATOR IN MAIN CASTING; MESSRS. HERBERT MORRIS, LIMITED.

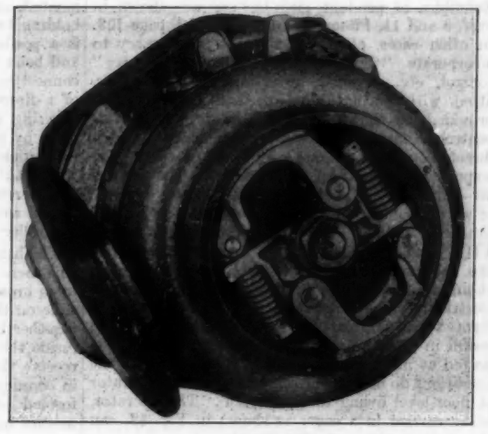


FIG. 14. CENTRIFUGAL BRAKE; MESSRS. HERBERT MORRIS, LIMITED.

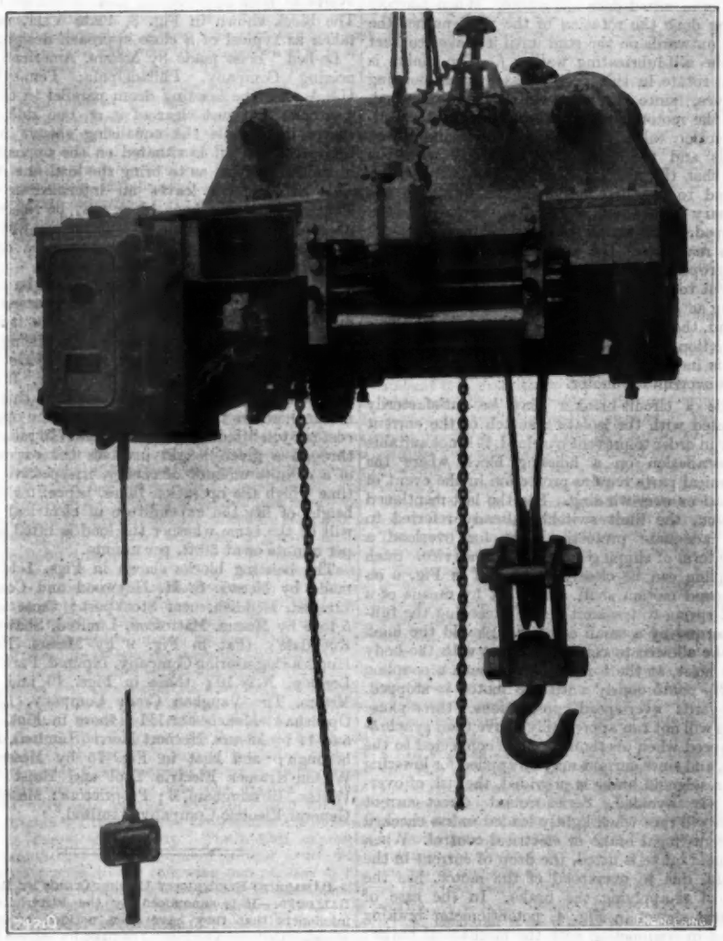


FIG. 15. DIRECT-LIFT RUNWAY HOISTING BLOCK; MESSRS. THE WITTON-KRAMER ELECTRIC TOOL AND HOIST WORKS.

a flat base. This method is shown in Fig. 2, Plate VIII, which, it will be recognised, is the same type of block as shown in Fig. 1. The runway hoist shown in Fig. 9, Plate IX, also has a motor secured in this way, though this is not apparent in the illustration. Another method is that known as flange-mounting, examples of which are shown in Fig. 6 and Fig. 12. In Fig. 13, on this page, another different method is shown, the stator of the motor being incorporated in the heavy main suspension casting. In all cases the exterior of the motor body should be fully exposed to facilitate natural cooling. In some protected-type motors a fan is attached to the rotor to induce air circulation. It is considered well worth the slight additional cost involved to mount the motor spindle in ball bearings, in fact, such bearings may with advantage be employed elsewhere in the hoist, since they improve its efficiency and require little attention. Where grease-gun lubrication is employed, the inlet nipples should be grouped so as to be readily accessible to a man standing on a ladder. Such grouping has the further advantage of preventing any lubricating point from being overlooked.

The ratings of the motors usually fitted to the blocks here referred to range from 1 brake horse-power to 10 brake horse-power. When direct-current motors are used, speeds of about 800 r.p.m. to 900 r.p.m. are normal practice. Direct-current motors are series-wound, some being provided with interpoles to improve commutation. When three-phase motors are fitted, they are normally of the squirrel-cage type, though for the larger sizes of hoist slip-ring motors are occasionally employed. High-resistance rotors are used to secure a maximum starting torque. As regards power requirements, crane-makers have adopted, for their own convenience, an arbitrary unit of hoisting capacity, which they call the "foot-ton." The capacity of a hoisting mechanism in foot-tons is measured by the product of the maximum working load in tons and the corresponding speed of the lift in feet per minute. Hence, assuming an efficiency of 100 per cent., 1 brake horse-power $= \frac{33{,}000}{2{,}240} = 14{\cdot}7$ foot-tons. In actual blocks in which machine-cut gears and ball bearings are used throughout, a hoisting capacity of, say, 12 foot-tons, can be allowed per brake horse-power of motor rating, this allowance corresponding to a mechanical efficiency of about 81·5 per cent. For spur gearing and plain bearings, an allowance of 10 foot-tons per brake horse-power (efficiency = 68 per cent.) is usual, while for worm-geared and spur-geared blocks, such as that illustrated in Fig. 10, Plate IX, it is customary to allow 6 foot-tons per brake horse-power (efficiency = 41 per cent.).

Experience has shown that the control gear of the electric hoisting block is of vital importance, since it is generally operated by unskilled labour, and may be subject to overload. It is, moreover, usually situated in an exposed position overhead, so that inspection and reconditioning are likely to be deferred. When controls of the rheostat type are used, the necessary operation by means of pendant cords cannot give the same delicacy of touch as is obtained with direct handle operation. Most of the motors in use for hoists are rated at 1½ brake horse-power or less, and may be switched

directly on the mains. In such instances, simple contactor control operated by pendant "on" and "off" push-buttons has much to recommend it. Examples of pendant push-buttons are shown in Figs. 9 and 11, Plate IX, and in Fig. 15, page 103. In other cases, especially when it is necessary to incorporate "dead slow" or "potentiometer" control, etc., a small reversing drum-controller, fitted with normal blow-out and arc-shields, is provided, as shown in Fig. 3, Plate VIII. This controller may have two to four steps in each direction, and is operated by pendant cords with a spring return to the "off" position. The particular controller shown in Fig. 3 is a good example of an accessible arrangement for wiring and maintenance. It will be evident from Fig. 4, Plate VIII, that the controller is interconnected with the mechanical load-brake and, by the central chain, to the hoisting-limit trip lever. When an electric block is built in a travelling carriage, to form a transporter, it provides a type of hoist useful in cases where the loads have to be transported at more than a walking speed or where the conditions do not permit the passage of the operator at floor-level owing to obstruction. The operator, being carried in a cage, as shown in Fig. 12, can then actuate the controller directly.

For such foundry operations as the lifting of patterns and the closing of moulds, as well as for machine assemblies requiring precise adjustment, a very slow vertical lift may be required. This motion can be obtained, electrically, by the well-known system of "armature-diverter" control when direct-current supply is used, and, mechanically, by special braking arrangements. An interesting layout developed by Messrs. Matterson, Limited, Rochdale, embodies a two-motor drive for the hoisting mechanism, each of the motors having its own solenoid brake and control gear. While the main motor has normal first-reduction gear, the smaller auxiliary motor has a first-reduction gear of high ratio, which gives a final "creeping" speed. Each motor is connected to the hoisting gear through a differential device incorporating bevel gears, and the operator can bring into action either one or both of them in any combination "up" or "down." It is thus possible, for instance, to lower a moulding box at a rapid rate until the locating pins are approaching engagement, and then to reduce the speed of descent to the very slow rate desirable during the pin engagement and the closing of the mould.

When a block is suspended from an overhead trolley and is required to make a horizontal traverse of more than a few feet, bare runway conductors and current collectors will be required. These present no special features and carry only a small current, but, in view of the severity of the service, in many instances, all details should have a considerable margin of strength, both mechanically and electrically. For reasons of safety during the inspection of a block and its runway, an accessible enclosed disconnecting switch must be provided, and all metal parts, excluding conductors, must be earthed.

Most of the hoisting blocks illustrated in this article have spur gearing throughout. That shown in Fig. 10 has a worm gear first-reduction, but the block illustrated in Fig. 11 has double-helical gears for this motion, the gearcase being seen to the right. All rope drums have machined grooves, these grooves being deeper than those usually found in other winding appliances. Occasionally roller rope guards are found and certain makers provide positive travelling guards, which, in some instances, also function as trips for the over-hoist, and lower limit switches. Different forms of this gear are shown in Fig. 7, Fig. 10, and Fig. 15.

As regards braking for lowering, practice differs. Some firms, as may be gathered from Fig. 10 and Fig. 11, fit a compact form of automatic solenoid holding brake on an extension of the motor spindle. The hoist shown in Fig. 9 is also fitted with this type of brake. It is possible, though not usual practice, to fit a hand release to control lowering from the floor, without energising the motor in reverse. A centrifugal "governor brake," or perhaps more exactly, a speed controller, is shown in Fig. 14, page 103, this device being fitted to the hoist illustrated in Fig. 11, in which its cover is visible on the left. Such a brake is, however, merely a speed-limiting device and has to be supplemented, as in the hoist just referred to, by a load-holding brake. In this example the holding brake is a positive mechanical device of the multi-plate and helix type. Electrically, an armature-diverter connection may be applied to limit the speed of a direct-current motor in either direction, while lowering on direct-current supply may be regulated by potentiometer control, which, again, must be supplemented by a positive holding brake. The braking gear of the hoist shown in Fig. 4 is of interest. The chain-operated brake is interlocked with the controller, and is applied when the controller is moved to the "off" position.

The brake shown in Figs. 5 and 6 is unusual. In this there are two cones a of asbestos fibre moulded upon bronze sleeves. The sleeves are grooved to slide on the splined first-motion shaft and are held together by a spring pressure from 15 lb. to 20 lb. inside the muff b. The muff is coned internally to receive the cones by which it is supported and is, in consequence, free of the shaft. Externally it is formed with a ring of spur-tooth gearing which meshes with the teeth of a pinion c having teeth at an angle of 45 deg., at which angle, relative to the shaft axis, the pinion is set. The inner face of the pinion is formed as a dog clutch engaging with a similar fixed clutch d. The stud e, on which the pinion is mounted does not rotate. When hoisting is being done the rotation of the muff pushes the pinion outwards on the stud until it makes contact with the self-lubricating washer f. The pinion is free to rotate in this position as long as hoisting continues, since the dog-clutch is disengaged. When the motor is reversed for lowering, the converse action takes place, the pinion being thrust inwards and the dog-clutch engaging, with the result that the muff is locked. The cones, being attached to the first-motion shaft, rotate in the stationary muff and a braking torque is thus developed. The torque obviously depends mainly on the reaction at the pinion teeth and is, therefore, proportional to the suspended load. It is sufficient to hold the maximum rated load and the braking action is silent and automatic. In lowering the load, the power applied by the motor overcomes the friction of the cones and whatever lowering speed is imposed, the speed of descent of the load cannot overrun the motor.

While a circuit-breaker may be satisfactorily associated with the isolating switch of the current supply in order to prevent overload, it is not suitable for installation on a hoisting block where the mechanical parts require protection in the event of overload or over-winding. For the last-mentioned condition, the limit switches already referred to afford adequate protection, but for overload a simple form of slipping coupling is of service. Such a coupling can be clearly recognised in Fig. 6 on the second motion shaft. It is set by means of a helical spring to transmit power exceeding the full-load torque by a small amount. Should the hook block be allowed to come in contact with the body of the hoist, at the top of the lift, such a coupling will slip continuously until the motor is stopped. As regards over-speed precautions, three-phase motors will not run appreciably above their synchronous speed when overhauled while connected to the mains, and since current may be applied for lowering when a solenoid brake is provided, the risk of over-speed is avoided. Series-wound direct-current motors will race when lightly loaded unless checked by a centrifugal brake or electrical control. When a solenoid brake is fitted, the drop of current in the solenoid, due to overspeed of the motor, has the effect of re-applying the brake. In the case of the hoist shown in Fig. 4, potentiometer braking is fitted in conjunction with the mechanical brake; otherwise, on a direct-current supply, and if badly adjusted, racing might occur when lowering.

Owing to the moderate lifting capacity of electric blocks in general use, the deadweight of the block amounts to a fairly high percentage of the maximum load it is constructed to lift. Weight is, therefore, an important factor as regards suspension design. No fixed ratio of weight to load exists. Some purchasers prefer a comparatively light design, which can be readily achieved while still retaining an adequate safety margin. Other buyers prefer a heavier machine, of a design capable of withstanding exceptional overloading and abuse. Between these extremes there are a number of medium-weight designs. If the weights of typical hoisting blocks are plotted, it is evident that they are more nearly related to the "foot-ton" capacity in each case than to the nominal rated load. The former rating determines the size of the motor and its control gear, whereas the latter is independent of these important components. With standard blocks arranged for eye suspension, a reasonable tentative estimate of the deadweight may be found thus: for blocks of heavy construction the deadweight = (28·5 × foot-tons) + 500 lb. For blocks of light construction, the deadweight = (11·4 × foot-tons) + 250 lb.

For some operating conditions, such as between the floors of a warehouse, every inch of vertical stacking space may be valuable, so that the load hook should be capable of being hoisted to as near the point of suspension as possible. With standard blocks of 1-ton capacity, as dealt with above, the minimum distance, measured from suspension eye to load hook, varies from 1 ft. 11 in. to 3 ft. 3 in., according to the design of block. This difference of hook-approach might determine the selection of the type of block for a particular application, but all makers have alternative designs to improve the available hook-approach of their standard blocks. The block shown in Fig. 8, Plate VIII, may be taken as typical of a close approach design. The "Lo-hed" hoist made by Messrs. American Engineering Company, Philadelphia, Pennsylvania, U.S.A., has the hoisting drum parallel to the runway joist and just clear of it on one side of the centre line, while the equalising sheave for the four-part rope lift is situated on the opposite side in such a position as to bring the load line central. This arrangement leaves an intermediate space through which the hook block may be raised until its rope sheaves actually touch the runway joist. This is clearly the utmost that can be done to shorten the hook approach distance.

All the types of block illustrated can be altered, by minor modifications, to given an increased lifting range. For constantly-recurring long lifts, it is often distinctly advantageous to increase the lifting speed, although this change involves an increase in the brake horse-power and size of the motor. It should be noted that in spite of the fact that this larger motor increases the cost of the block, the operating cost per ton lifted remains unaltered. To raise a load through a given height involves the expenditure of a definite amount of energy, irrespective of the time which the operation takes, hence, for a given height of lift the expenditure of electrical energy will be the same whether the load is lifted at 5 ft. per minute or at 50 ft. per minute.

The hoisting blocks shown in Figs. 1 to 4 are made by Messrs. S. H. Heywood and Company, Limited, Reddish, near Stockport; those in Figs. 5 to 8 by Messrs. Matterson, Limited, Shawclough, Rochdale; that in Fig. 9 by Messrs. Paterson Hughes Engineering Company, Limited, Park Royal, London, N.W.10; those in Figs. 10 and 12 by Messrs. The Vaughan Crane Company, Limited, Openshaw, Manchester, 11; those in Figs. 11, 13 and 14 by Messrs. Herbert Morris, Limited, Loughborough; and that in Fig. 15 by Messrs. The Witton-Kramer Electric Tool and Hoist Works, Witton, Birmingham, 6; Proprietors: Messrs. The General Electric Company, Limited.

DAMAGE TO ELECTRICITY UNDERTAKINGS BY BARRAGE BALLOONS.—It is announced by the Electricity Commissioners that they have been notified by the Air Ministry that since accidental damage by balloon barrage equipment is the direct result of precautionary measures taken in anticipation of action by the enemy, such damage occurring on and after February 1 will be treated as "war damage." While, therefore, all claims regarding damage due to drifting barrage balloons up to and including January 31, 1941, should be addressed to Balloon Command, Royal Air Force, Stanmore, Middlesex, on the other hand, particulars and claims of damage occurring on and after February 1 should be forwarded to the Commissioners and not to the Balloon Command.

RECOVERY OF METAL SWARF AND SCRAP.

WHILE some engineering firms have efficient systems of economic swarf disposal and of recovery of scrap metal, the subject as a whole has received little attention, and this neglect renders a paper on the subject by Mr. D. F. Galloway, Wh.Sc., B.Sc., presented in December, 1940, to the Institution of Production Engineers, of particular interest at the present time. The paper, which is entitled "Efficient Control and Disposal of Swarf and Scrap Metal, is summarised below.

The author commences by mentioning the fact that the problem of handling swarf and scrap has no universal solution. Many factors enter, such as the material, the quantities involved, the rate of production, the form of the swarf and scrap, and the purity of the by-product, *i.e.*, whether it consists only of one metal or of a mixture of several metals. Added to these is the question whether the metal is to be sold to a dealer or whether the firm is to re-melt it for their own foundry. The paper then traces the course of the swarf from the machine to the cupola or crucible. The metal chips produced by such processes as milling, sawing and grinding, are usually small enough for easy handling, but the swarf resulting from turning, boring, drilling and similar operations is often produced so rapidly and in such a form that it is necessary to take steps to control it immediately it leaves the work. When single-point cutting tools are used, deflectors or chip-breakers can be employed to break it up. The deflector may be a loose strip clamped on top of the tool at a little distance from the cutting edge, so forming a step against which the swarf is broken off as it is produced. The chip-breaker is a similar step, formed, however, by grinding the top face of the cutting edge. This results in some loss in cutting efficiency but the loss may be kept to a minimum by grinding so as to maintain the correct cutting angle. The step in most cases is ground parallel to the cutting edge but it is claimed that a step lying at an angle to this edge definitely breaks the coiled swarf into convenient lengths. When parallel, the step, for cutting steel, should be about 0·01 in. to 0·02 in. deep and of a width approximately equal to three times the feed.

The ground-in chip-breaker is stated to be very effective with cemented carbide tools as they retain their form much longer than those on high-speed steel tools. With ductile materials such as steel, a tool without a chip-breaker is apt to produce long strips of swarf which are not only apt to score the surface of the finished cut but may become entangled in the working parts of the machine. The form of chip-breaker consisting of a groove at the back of the cutting edge is not recommended, since it weakens the cutting edge. Chip breakers are not necessary for intermittent cutting, such as when taking the first roughing cut on irregular surfaces or surfaces having slots, etc. The grinding of chip-breakers should be done, if possible, by holding the work in a suitable fixture and using an impregnated diamond wheel. The long helical swarf produced during heavy operations with large diameter drills in steel can generally be broken by grinding notches at irregular intervals in the drill lips. Alternatively, a shallow groove just above the inside face of the lip and parallel to the lip edge makes an effective chip-breaker, but such a groove finally disappears on subsequent grinding; the notches, however, are easily re-cut after grinding. Numerous investigations have been made to determine the correct size and form of the helical flutes along which the swarf must pass to clear the drill point. The problem is, however, a complicated one as, for one thing, the helix angle of the flute affects the main cutting angle of the drill, but it is clear that with correctly ground drills in conjunction with an appropriate flute helix angle many of the difficulties of swarf disposal can be eliminated and increased output and drill life secured.

The method of collection of the swarf varies with the machine. In quantity production machines, such as bar automatics, a cam-operated deflector, which directs the swarf during cutting into one channel and the finished work into another, is often fitted, while in other machines a transfer arm ensures that the finished work is deposited correctly. The author expresses the opinion that the problem of getting swarf from the cutting point to the collecting pan or base of the machine is one to which machine-tool designers should give greater attention. Sloping surfaces should be introduced as far as possible, recesses and projections eliminated, or in some cases the whole machine may be tilted so that swarf disposal is facilitated without impairing the functions of the machine. Regarding the removal of swarf from the machine, in many shops where the rate of swarf production is not great, a pan or bin, under or near the machine, into which the chips can fall or be easily tipped, is customary. When such bins are too large to be removed by hand they may be set on feet so that an elevating truck can be run under them, one man being able to attend to a large number of machines. With machines having raised pans, the swarf can be scraped off into barrows. Shovels and brushes, while adequate for small chips, are not suitable for long coiled chips which can more readily be handled by means of a hooked rod.

On some machines, such as large lathes and multi-spindle automatics, where the rate of metal removal is great, various forms of conveyor, often of the Archimedian-screw type, are used. A wide conveyor with a short travel at right angles to the machine-spindle axis is a convenient form. A plate-type conveyor can be arranged in a comparatively small space and so that it projects, at the rear of the machine, to overhang the collecting bin. The swarf from large machines, such as wheel lathes and vertical boring mills, not using large quantities of cutting lubricant, may be arranged to fall through the open base of the machine, as the chips are usually heavy and short, either into a bin on wheels or down a chute into a portable bin, removal of the bin in both cases being effected through a pit at the side of the machine. The subsequent transport of the contents of the bins to the scrap yard may be either by conveyors or railway trucks, and if large quantities are to be handled the use of electromagnets may be found satisfactory.

The separation of the cutting lubricant from the swarf is next referred to. The strainers usually fitted to the collecting pans separate only a small portion of the lubricant, a large volume adhering to the chips, the complete drainage of which by gravity involves both considerable space and extended time. The use of a centrifugal separator is recommended as a much quicker and very effective method, and an illustration is given of three separators, serving a number of machines, from which over 500 gallons of oil a day are recovered. The oil so separated may contain fine swarf, the proportion varying with the cutting operation involved, and this may set up various difficulties; it may, for example, clog the cutting lubricant pumps. The oil should, therefore, be treated to remove the fine swarf before re-use. Strainers may be sufficiently selective for certain operations and types of pump, but the effective separation of very fine swarf requires a settling tank having properly-arranged baffles. Where absolute purity of the oil is essential, purification is effected by machines operating on the same principle as the centrifugal separator. Magnetic methods of separation have also proved very effective. In the latest designs, the oil passes by gravity through a series of perforated boxes filled with closely-spaced metal grids. These grids are magnetised and the fine swarf is thus arrested. Clearly, this method is not available for the majority of non-ferrous metals but is particularly useful in the separation of ferrous particles such as are produced by, say, thread grinding.

The long coiled swarf previously referred to as resulting from the turning and drilling of steel is difficult to handle and if it is produced in any considerable amount it is desirable to break it up. Machines somewhat resembling the swinging-hammer type of stone crusher are available for this purpose. The speed of these machines varies from 500 r.p.m. to 900 r.p.m. and the power consumption from 25 h.p. for a machine crushing 1 ton of swarf per hour to 75 h.p. for a machine crushing 6 tons of swarf per hour. Some modern machine tools incorporate swarf-breaking devices; for example, certain automatic machines for rapid turning. The swarf is not only broken up but is baled and delivered in a compact form ready for transport.

In some workshops engaged on very varied work it is not practicable to keep all swarf of different materials separate, so that mixtures of brass, steel, aluminium, cast iron, etc., have frequently to be handled. Various forms of sorting machine are available, the precise type depending on the materials to be separated, the approximate percentage of the iron and steel content of the mixture, the approximate size of the swarf handled and the rate of separation required. These separating machines are, naturally, magnetic. A type having a wide range of performance consists of a belt inclined at a steep angle and running over top and bottom pulleys, the frame in which the pulley shafts are carried being capable of adjustment to vary the inclination of the belt. A large number of steel inserts are arranged in staggered rows in the belt, and a series of stationary electromagnets of alternate polarity are situated below the upper strand, which travels in an upward direction. The swarf is fed on to the upper strand, generally by some positive-acting device, at a point about one-third the length of the strand from the top. The ferrous chips attracted to the inserts jump from one to the other as the belt moves over alternate magnetic poles and are eventually discharged over the top pulley. The jumping action keeps the mixture agitated so that the non-magnetic particles are free to gravitate down the belt to a receiver below the bottom pulley.

A simpler type of machine suitable for separating iron and steel from non-magnetic materials embodies electromagnets arranged so as to create a strong stationary magnetic field in the front half of the rotating brass drum in which they are contained. The mixture is fed on to the top of the drum from a hopper of the oscillating tray type. The non-magnetic materials simply fall off the drum into a pan below it while the magnetic parts adhere to the drums until they are carried out of the magnetic field when they fall into a second pan at the rear of the drum. A convenient drum diameter is 14 in., the output being about 2 cwt. per hour for each 6 in. width of drum, with a power consumption of approximately 100 watts. About 95 per cent. of the magnetic material is extracted when the mixture is passed over the drum once, a more complete separation being secured, if required, by passing the contents of the ferrous pan over the drum again or by using a two-stage machine with successive drums. This machine is suitable for dealing with mixtures containing over 3 per cent. of iron and steel.

This limitation arises from the unavoidable loss of field strength due to the thickness of the drum, a loss which also occurs in the somewhat similar machine known as a magnetic pulley. In this machine, the mixture is fed on to a belt passing over the pulley, round the entire periphery of which a constant magnetic field is maintained. The separating action is practically identical with that of the magnetic drum. The efficiency depends largely on the thickness of the belt, the results of an interesting investigation on the influence of thickness being shown in a curve in the paper. Briefly, these show that with a belt of negligible thickness, which would be impracticable in service, the pull per square inch of sorting surface was, in the test installation, about 80 lb.; with a belt thickness of 0·05 in., the pull was 30 lb.; with one of 0·1 in., it was 20 lb.; with one of 0·2 in., it was 10 lb.; while at the maximum thickness tested, viz., 0·5625 in., it was under 2 lb. per square inch of sorting surface. There are many types of magnetic separating drums and pulleys available; in some, the possibility of a piece of non-magnetic material being held down on a drum by magnetic material and delivered to the magnetic material pan has been countered by substituting a series of fields of alternate polarity for the constant magnetic field. The iron and steel components of the mixture, as they are carried through the fields, then turn over and over as they pass alternate north and south poles, and the non-magnetic material is liberated. Again, in some types of drums and pulleys in which the field is reversed in polarity across the width of the drum, the resulting circumferential neutral zones may give rise to trouble when handling fine-grained mixtures. This difficulty can be overcome by replacing the brass drum by a steel one in which the thickness and the location of the magnetic system are arranged so that the magnetic flux lies more or less evenly over the separating surface.

For mixtures in which the chips are either very small or are actually in powder and have an iron or steel content of less than 3 per cent., machines having vibrating trays, generally arranged in a form resembling sloping steps, are the most satisfactory. The inclined trays are of non-magnetic material and carry steel bars, which are magnetised by induction from stationary primary coils situated below them. The material flows by gravity down the inclines and the iron and steel particles adhere to the magnets. When these become fully charged, the machine must be stopped and the magnetic particles removed, the non-magnetic particles in the meantime having gravitated to a receiving pan. The separating operation, while being efficient, is necessarily slow, hence the machine is usually employed for the low percentage magnetic contents mentioned. When the metals to be separated are fixed together, hand sorting must be resorted to. Dirt and tarnish frequently obscure the nature of the metal, but the presence of an iron or steel screw, etc., in a scrapped part, a broken drill or tap, and so forth, can be detected, and the part set aside for removal, by the use of an electromagnet either suspended above the sorting bench or arranged flush with it. The cost of such an appliance is generally warranted by the increased price obtained for non-ferrous scrap which is perfectly free from ferrous inclusions.

Normally, the separation of cast iron and steel chips can only be made in a rough fashion. One method is to feed the material, which has already been passed through a breaking machine, into a rotating conical screen. The cast iron has been broken up in these to a size which will pass through the mesh of the screen, but the steel, as a whole, is too large for this and is discharged from the open larger end of the screen. As the separating action is based on size only it will be evident that it cannot be wholly complete, though for most purposes the partial separation effected is sufficient. Aluminium can be separated from other metals by flotation. The mixture of chips is immersed in a solution having a greater specific gravity than the aluminium, Duralumin, or alloy it is desired to separate. These chips naturally float to the surface of the solution and are removed by perforated ladles. The heavier chips, iron, steel, brass, etc., sink and are retained in a perforated pan at the bottom of the solution tank, the pan being removed at

intervals. The surface chips and the sunk chips are washed in separate tanks to remove the adherent solution, the wash-water being then evaporated to recover as much of the solution at its original density as possible. The washed sunk chips may be then passed over a magnetic separator if desired. This method of separation is stated to be very rapid and inexpensive if the processes are properly arranged so that separation, washing and solution-recovery proceed continuously and efficiently.

In many workshops mechanical sorting is not necessary, the swarf from machines turning out large quantities of parts of the same material being readily separated, but in any case the sorted material has to be put into a form suitable for introduction to the remelting plant. Cast iron swarf is usually in small chips, which may take the form of flakes or needles and are brittle. This swarf cannot be handled in the same way as that of steel. Furthermore, steel chips, however small, can be utilised in electric furnaces, but in the case of cast iron, oxidation and loss in the blast make it very uneconomical to feed loose swarf to the cupola. The swarf may be packed into containers, which are then fed to the cupola. Objections to this system are the cost of the containers and the fact that loss due to oxidation and in the blast may still occur to an extent dependent on the tightness with which the chips are packed. An alternative method is to compress the swarf into briquettes of convenient size and having a density of at least 70 per cent. of the solid material. Cast iron swarf lends itself so well to the briquetting process that no binder is required. A briquetting plant usually consists of a bucket elevator to deposit the swarf on to a hopper discharging on to an automatic measuring table, this plant being situated above the toggle-press in which the actual briquetting is done. From the measuring table the press is fed with chips at a uniform rate, the finished briquettes being subsequently delivered to a table in front of the press. The power consumption of a briquetting press is approximately 12 h.p. when converting 1-ton of swarf per hour into 600 or 700 briquettes.

Occasionally it may be necessary to crush the swarf before feeding it to the press, in which case a tumbler barrel may be added to the plant. A rotating barrel or ball mill is also useful when it is desired to recover metal chips from ashes, sweepings, etc. Iron and steel can be almost completely separated by the magnetic separators already described, but where brass, aluminium and other non-magnetic material has also to be extracted, the ball mill, viz., a rotating drum containing loose hard metal balls and in this connection often known as a cinder mill, is of service. The mixture is introduced into the drum and the grinding is done dry, the ash, etc., being reduced to dust, which is discharged through sieves. The recovered metal is then removed from the drum ready for further sorting by a magnetic separator if the mixture contains both magnetic and non-magnetic materials.

Steel swarf or sheet scrap can usually be baled or bundled, though in many workshops it is handled loose. Some firms, especially those producing irregular bulky sheet metal scrap, resort to hand-baling, a process which is quite efficient when properly organised. Baling and bundling presses capable of dealing with a wide range of metal scrap are, however, available. The simplest of these are hand-operated through a lever and ratchet actuating a rack and pinion. The size of the finished bales is approximately 10 in. by 9 in. by 8 in., the free scrap having occupied a minimum space of 48 in. by 10 in. by 9 in. The power-driven presses are, as a rule, hydraulically-operated and usually compress the scrap in two stages, two rams at right angles being employed with, occasionally, a third ram for ejecting the bale. The power consumption is approximately 4 h.p. per cwt. of bale, and machines are made which handle bales weighing over 3 cwt., the scrap being compressed to less than one-third of the volume occupied before baling. The advantages of the compact form resulting from baling are that the material is not only easier to handle and store, but is more readily introduced into the melting furnace. Some ferrous scrap, such as fine filings, is so small that it is difficult to handle by any of the foregoing methods. This material may be fused into pieces sufficiently large for feeding into the furnace. If an efficient sintering plant is employed, the whole process can be carried out automatically and at a high speed. The fine material is continuously and uniformly fed to a conveyor, which carries it past a flame effecting the required fusion. The resultant sintered material can be used in the production of high-grade iron.

Non-ferrous swarf can be treated either in the same way as steel, or, as is more usually the case, can be dealt with in machines of the type used for cast iron, since most non-ferrous swarf is easily briquetted. Sometimes this kind of swarf is stored and transported in sacks. The ultimate object of the efficient handling of swarf and scrap is adequate recovery of the material, which is of great value, especially under present conditions of increasing demand and limited supply. The final stage of recovery is the actual re-melting, though this cannot be effected without certain losses. Nevertheless, by proper preparation, including compact baling or briquetting, some of the chief sources of loss, such as oxidation, are considerably reduced. By employing a well-arranged plant, cast iron chips can be briquetted at a cost of less than 7*s.* per ton, and if the briquettes are used to form 10 per cent. to 20 per cent. of the cupola charge, it is possible to save up to 1*l.* per ton of melted iron. The briquettes are so compact that oxidation is limited, although the density and structure are such that the graphite is burnt off just above the fusion zone. The carbon lost is not entirely replaced during fusion, so that the final result is a reduction in carbon, which permits the production of high-grade castings at a considerably reduced cost.

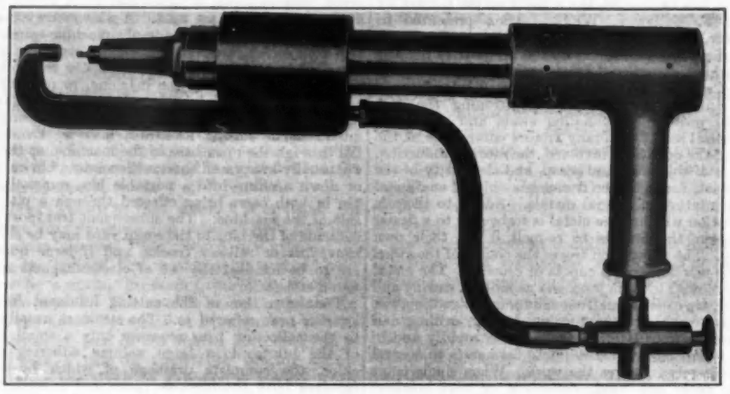
While a reduction in the loss of any material is always desirable, no effort should be spared at the present time to conserve every scrap of aluminium. It is, therefore, imperative that all possible steps should be taken to prevent the excessive oxidation to which this metal is prone. The scrap should be well cleaned by degreasing, roasting to remove foreign organic matter, etc., and then baled or briquetted. The presence of moisture in the furnace is particularly harmful, and special care must be taken to ensure that the bales are perfectly dry before they are introduced into the furnace. The prepared scrap must be completely submerged in molten metal, so that it is not affected by the oxygen of the atmosphere. Small scrap must not be melted down in the pre-heating chamber, which is provided in some furnaces to prevent cooling of the melt by incoming metal. Any fluxes used should be introduced directly into the molten metal to make sure that they do not act as a medium for the introduction of moisture. If all these precautions are taken, the loss due to oxidation can be reduced to between 1·5 per cent. and 3 per cent., an amount which compares favourably with the 1 per cent. to 1·5 per cent. when melting ingots. To avoid the uncertainty regarding the precise composition of scrap, it should be melted in the largest convenient quantities and cast into ingots, so that accurate analysis then becomes possible and effective alloying is facilitated.

Grain Transportation in Argentina.—During 1939, the Argentine railways transported 14,206,791 tons of grain; road and river transport, on the other hand conveyed rather less than two million tons in the same period.

The Control of Wood Wool.—In view of the need for confining the use of wood wool to essential purposes, it has been decided to introduce, as from February 1, a system of control over the deliveries of the material by manufacturers and merchants. Persons and firms desiring to purchase wood wool are now required to produce a duly certified application form in support of their order. Provision has been made, however, whereby small consumers—where the total requirements of wood wool do not exceed 6 cwt. in any one period of three months—need not apply for a certificate and wood-wool manufacturers and merchants have been authorised to deliver such small quantities in the normal manner. Inquiries regarding the system of control, and requests for application forms, should be addressed to the Assistant Secretary, Industrial Supplies Department, Board of Trade, Millbank, London, S.W.1.

COMBINED DIMPLER AND RIVETER.

MESSRS. CONSOLIDATED PNEUMATIC TOOL COMPANY, LIMITED, LONDON.



COMBINED DIMPLING AND RIVETING MACHINE.

The one-shot riveting hammer of the push-handle type, made by Messrs. The Consolidated Pneumatic Tool Company, Limited, 232, Dawes-road, London, S.W.6, is one of the firm's well-established tools and its characteristic features will be recognised in the accompanying illustration, which shows, however, a new combined dimpling and riveting machine. This tool, since it weighs only 6 lb. and has an overall length of only 16¼ in., is readily portable and should be of considerable service in those aircraft assembly operations in which it is difficult to make use of a standard type of flush riveter; the employment of the latter tool is usually limited by difficulties of access. By modifying the standard one-shot riveting hammer, however, and attaching to it a yoke or jaw which forms a hold-up for the operation, the makers have produced a handy tool which not only removes the disabilities of the standard hammer in confined spaces but enables both dimpling and riveting to be carried out effectively. The tool will close rivets up to $\frac{1}{4}$ in. in diameter, and is, of course, air operated.

The yoke is mounted on the barrel of the hammer and is traversed as required by an integral cylinder sliding on that barrel. As there are two movements involved, namely, that of the riveting or dimpling tool and that of the hold-up, two controls are necessary. The yoke is shown open in the illustration, that is, in a position which enables the hold-up to be placed under the parts to be operated on. This open position is automatically provided for by an internal spring in the traversing cylinder. The cylinder is connected to the air supply by means of a flexible pipe and a control press-button valve is fitted at the point of connection. The button is pressed when the yoke is being placed in position, the action of the spring holding it open. When in place, the button is released and air is admitted to the cylinder, thus closing the hold-up and tool by overcoming the spring pressure. The handle of the tool is then pressed, this action admitting air behind the hammer piston and bringing it down with one sharp blow on to the rivet sett or dimpling tool. The force of the blow can be regulated by means of a knurled-head screw, this arrangement providing a very sensitive adjustment. The rivet sett and dimpling tool are interchangeable in the nose of the machine. It will be clear that the machine as illustrated has a yoke arranged to provide a short throat depth only, but it will also be obvious that variation of this depth is only a matter of modifying the yoke, which can be supplied to give any required throat depth up to 6 in. Moreover, special types of yoke to suit unusual requirements can be obtained.

Importation of Silver Ores.—The Board of Trade informs us that the open general licence permitting the importation, without further licence, of silver ores, concentrates and residues, has been revoked as from February 5. From that date separate licences will be necessary, except in respect of goods which are proved to the satisfaction of H.M. Customs and Excise to have been despatched to the United Kingdom before February 5 and are imported into this country before April 5. Applications for licences should be addressed to the Import Licensing Department, 25, Southampton Buildings, London, W.C.2.

LOW-PLATFORM TRANSPORTING TRUCK.

MESSRS. E. H. JONES (MACHINE TOOLS), LIMITED, LONDON.

FIG. 1.

FIG. 2.

LOW-PLATFORM TRANSPORTING TRUCK.

THE development of workshop appliances is often contributed to by firms that have evolved a certain device for their own use and have found it so serviceable that they decide to put it on the market. Another case of common occurrence at the present time is that the supply of some useful appliance formerly imported has been cut off, so that the importers decide to manufacture it for themselves. The low-platform transporting truck shown in the accompanying illustrations is a good example of the latter case. Messrs. E. H. Jones (Machine Tools), Limited, Edgware-road, The Hyde, London, N.W.9, previously imported this type of truck from the Continent and used it for the rapid handling of machine tools in their workshops and showrooms. The outbreak of war resulted in the cessation of supplies, and, as Messrs. Jones found the truck very useful, they had some manufactured for their own requirements, and have since decided to make the truck available for other users. It is now being marketed as the "Lo-load" lifting truck.

The new truck has a recommended maximum lifting load of 15 cwt., and a platform with an inside area of 41 in. by 26 in. The top of the platform can be lowered to within 1½ in. of the floor level, a characteristic which is particularly valuable since it enables any load, within the lifting and platform surface capacity, to be rolled directly on to the platform without the help of blocks and tackle or other lifting appliances. In Fig. 1, a vertical milling machine is shown resting on a roller 2 in. in diameter. The truck operator has lowered the platform and is pushing it underneath the base of the machine. The general construction of the truck can be gathered from this figure. It is carried on wheels, with solid rubber tyres, the two front wheels being on fixed axles and the axles of the two rear wheels being mounted on castors. The platform is carried on four radius links, two on each side, at the front and, at the rear, on two pins, one on each side on the quadrant forming the short arm of the U-shaped lever used for lowering and raising the platform and for manœuvring the truck.

It will be noticed, by comparing Fig. 1 and Fig. 2, that this quadrant is not rigidly attached to the lever but is provided with a lug with which the lever makes contact when the platform and load are being lifted, as in Fig. 2. The ratio between the long and short arms is large so that the effort required of the operator is reasonably small. It will also be evident from both figures that a pair of stop levers carried on a common shaft engage with the quadrants. This arrangement locks the platform in its raised position so that the U-lever handle can be used in any position without risk of the load being lowered during transport. This freedom of the handle is necessary to enable it to be inclined at a convenient angle for pushing or pulling the truck or folded back towards the load when passing round an awkward corner. Incidentally, the truck can be easily turned in its own length, owing to the castor-mounted wheels. The stop levers can only be released by a device on the handle operated by a pedal, as shown in both illustrations. When raising or lowering the platform one foot must be used as well as the hands. Obviously, the employment of the truck is not limited to the transport of machine tools; it should be found useful, also, in workshops engaged on production or in such places as toolrooms and stores, for the transport of machinery parts, tools, scrap bins, etc.

THE BLACKBURN "BOTHA" I AEROPLANE.

THE two photographs reproduced on page 110 illustrate one of the "Botha" I general reconnaissance and torpedo-bombing aeroplanes constructed by Messrs. Blackburn Aircraft, Limited, Brough, East Yorkshire. As will be seen, the machine is a twin-engined, high-wing, cantilever monoplane, the engines being carried in nacelles formed below the main plane. Except that fabric is used for covering some of the control surfaces, the machine is of all-metal construction and its main overall dimensions are: span 59 ft., length 51 ft. 1½ in., and height 14 ft. 7½ in.

The fuselage is of the monocoque type, with flush riveting, and is formed with an enclosed cabin which houses a crew of four, who act, respectively, as pilot, navigator and bomb aimer, wireless operator, and gunner. A power-operated multi-gun turret, just distinguishable in Fig. 1, is mounted on the upper side of the fuselage behind the main plane, this position giving a wide field of fire. To permit intercommunication between the forward and rear positions, a gangway has been formed along the starboard side of the cabin, access to the cabin and to the pilot's seat being obtained through an entrance door on the starboard side. The pilot's seat is located on the port side of the forward end of the cabin, the bomb-aimer's prone position being on the starboard side.

The main plane consists of three sections, the centre section, which is rectangular in plan, carrying the two engine nacelles. The two outer sections, as shown in Fig. 1, taper considerably towards the tips, which are rounded, and these sections are set at a considerable dihedral angle, as will be obvious from Fig. 2. Balanced ailerons are fitted along a portion of the trailing edges of the outer sections and flaps are fitted to the trailing edges of the centre section. The flaps, which are operated hydraulically, may be used to improve the take-off and to reduce the landing speed. The main fuel and oil tanks are housed in the centre section, which also carries the undercarriage units. These consist of separate retractable oleo-pneumatic legs which are drawn up into the engine nacelles in flight. The landing wheels are raised hydraulically and when they are fully raised the openings in the nacelles are closed by mechanically-operated doors which can be seen in the open position in both illustrations; when closed, the doors form a smooth surface on the lower part of each nacelle. Hydraulically-operated brakes are fitted to the landing wheels. The tail wheel is mounted on an oleo-pneumatic shock-absorber strut; it has castor action with friction dampers.

The form of the tail unit is best shown in Fig. 1. Both the fin and the tail plane are unbraced cantilevers of stressed-skin metal construction; the rudder and elevators are also of metal construction, but are covered with fabric. The tail plane is located to the rear of the vertical fin, the leading edges of the former being swept back slightly towards the tips and the trailing edges of the elevators forming a straight line at right angles to the axis of the fuselage. As clearly shown in Fig. 1, the leading edge of the vertical fin slopes to the rear, while the trailing edge of the rudder is vertical. The rudder and elevators are balanced by a combination of inset hinge and horn balance; trimming tabs are also fitted.

The two radial engines employed are of the Bristol "Perseus" Mark XA sleeve-valve type. They are fitted with exhaust-collector rings and are enclosed in

deep-chord fairings with controllable cooling gills. The latter are shown in Fig. 1, but the other features of the power units can be more clearly seen in Fig. 2. The latter shows that three-bladed airscrews are fitted, these being of the constant-speed controllable-pitch type. At present, of course, it is not permissible to give the design data for the machine or to mention its performance. The general particulars given above, however, will doubtless be of interest. It may be mentioned, in conclusion, that the equipment of the "Botha" for marine work includes a collapsible dinghy, with inflation bottle, markers, floats, etc., in addition to the requisite wireless apparatus and electrical gear.

AN UNUSUAL PUMP TEST EXPERIENCE.*

ERRORS in pump testing, even when the trials are carried out by experienced staff, cannot be absolutely ruled out. Any error may make the pump appear either better or worse than it really is. The latter case is a nuisance, but is not usually dangerous, as an effort is naturally made to discover the cause of the fault; so that, apart from a certain extra expense and loss of time, the only danger would be in the combination of a pump that is, in fact, better than expected, and a faulty test failing to reveal this improvement. What the responsible technicians dread, and watch for, is a test error which flatters the pump; in such a case the psychological tendency on the part of all concerned is to accept the result. The danger, of course, is future disappointment, either on the plant in question or on some future machinery designed on the basis of the faulty test result. For this reason, any trial that purports to show an unexpectedly good result is most carefully scrutinised to eliminate any possible error, or to learn a most useful lesson in design if the improvement is found to be genuine.

The occurrence of a test which there is any reason to suspect is rare, but an interesting and rather extreme case occurred recently which illustrates the kind of possibilities that need to be guarded against. The subject of the test was an inclined-shaft axial-flow pump and an integral part of the plant was an easy bend, giving horizontal discharge. The pump was drilled for a permanent gauge connection just upstream from the discharge flange. On the test set-up, a straight length of pipe was connected to the discharge flange As a war-time compromise, a pipe slightly smaller in bore than the pump discharge was used, as there was none available of the full bore. A second gauge connection was provided some way along this pipe It was, of course, realised that results of meticulous accuracy would not be obtained, but no great inaccuracy was expected. The startling result was that the gauge near the pump flange showed about 4 ft. greater head than that on the straight pipe; but it was the latter which conformed to the expected performance of the pump, and, had the former been accepted as correct a pump efficiency of well over 95 per cent. would have been shown. It is also to be noted that the entire velocity head, as calculated by assuming uniform velocity distribution over the pipe section, was considerably less than 4 ft.

The pump in question was urgently required, so only a brief research could be carried out in the attempt to learn the causes of so strange a result. However, enough was discovered to show that it was due to the combination of (1) the differences of water velocity at different radii in the waterway (a feature necessarily present at most outputs in an axial-flow pump); (2) the bend (though an easy one); (3) the presence of ribs in the bend (which were necessary to enable the said bend to act as pedestal for the motor); and (4) the slight reduction in waterway diameter, downstream of the gauge tapping, due to the use of smaller bore pipe already referred to. This case is the more remarkable as the more usual experience is that a gauge tapping at a pump discharge gives a reading lower than one placed, in accordance with British Standard, "one to four pipe diameters from the outlet flange."

INSTITUTION OF NAVAL ARCHITECTS.—The 82nd annual meeting of the Institution of Naval Architects will be held on Wednesday, April 2, in the lecture hall of the Royal Society of Arts, John Adam-street, London, W.C.2. As already announced in our columns, no papers will be presented or discussed at the meeting and only formal business will be transacted. A programme of the proceedings will be issued in due course, together with a list of the papers selected for publication in this year's volume of the *Transactions*. Advance copies of these papers will be available and written contributions will be invited and published together with the authors' replies.

* From *The Allen Engineering Review*, No. 9 (January, 1941). Abridged.

THE LUBRICATION OF LEAD-BRONZE BEARINGS.

WE have received from Messrs. E. G. Acheson, Limited, 9, Gayfere-street, Westminster, London, S.W.1, some particulars of tests recently made on the lubrication of lead-bronze bearings, of which particulars we give the following summary. Although of comparatively recent introduction in Great Britain, this bearing alloy has been found to possess useful characteristics and, in consequence, has been employed, to give one example only, for the shafts of heavy-oil high-speed internal-combustion engines, such as those fitted to commercial vehicles of the omnibus type. It would appear, however, that the material has a drawback in that a trouble akin to incipient seizure may sometimes arise during the running-in period. This difficulty is not only objectionable *per se*, but is liable to be followed by others, though, if the running-in period can be passed successfully, lead-bronze bearings will, in general, have a long life. Messrs. Acheson, working from the knowledge that "Dag" colloidal graphite in oil had proved of great service in the initial lubrication of petrol engines, decided to investigate the possibilities of the compound with lead-bronze bearings.

The test was carried out on a bearing at two rubbing speeds, viz., 435 ft. per minute and 1,038 ft. per minute, and with varying loads commencing at 200 lb. per square inch. The load at both speeds was progressively increased until seizure occurred, and both a plain oil and a graphited oil were tried. At the rubbing speed of 445 ft. per minute and with plain oil seizure took place at a bearing load of 670 lb. per square inch. With the graphited oil at the same speed the bearing load at which seizure occurred was 1,208 lb. per square inch. With a rubbing speed of 1,038 ft. per minute, the seizure load with plain oil was 1,390 lb. per square inch, and, with graphited oil, 1,520 lb. per square inch. The last pair of load figures do not differ so widely as the first pair, and it would appear to be of interest to continue the tests at other speeds. It is stated that the steel shaft employed was protected, by the contained colloidal graphite, against the picking up of particles from the lead bronze, and, after a further short run with this lubricant the bearing face became reconditioned and was subsequently operated again at high loads. The coefficient of friction at the load of 200 lb. per square inch was, according to the graph of the tests, about 0·002 with the oil containing colloidal graphite and about 0·004 for the plain oil. At the seizure loads, the coefficient with the colloidal graphite was about 0·012, and with the plain oil about 0·0135.

BOOKS RECEIVED.

State of Tennessee. Division of Geology. Bulletin No. 49. *The Clays of West Tennessee.* By G. I. WHITLATCH. Published in Co-Operation with Tennessee Valley Authority. Nashville, Tennessee, U.S.A.: State of Tennessee Division of Geology.

General Engineering Handbook. Editor-in-Chief: PROFESSOR C. E. O'ROURKE. Second edition. London: McGraw-Hill Publishing Company, Limited. [Price 28*s.*]

Industrial Electrochemistry. By DR. C. L. MANTELL. Second edition. London: McGraw-Hill Publishing Company, Limited. [Price 38*s.*]

Internal-Combustion Engineering. Revised and edited by A. T. J. Kersey. London: Blackie and Son, Limited. [Price 17*s.* 6*d.* net.]

Fraser's Canadian Trade Directory, 1941. 507, University Tower Building, Montreal: Fraser Publishing Company. [Price 3 dols.]

United States War Department. Port Series No. 11. (Revised 1940.) *The Port of Portland, Oregon.* Washington: Superintendent of Documents. [Price 75 cents.]

American Society for Testing Materials. Index to A.S.T.M. Standards, Including Tentative Standards, Specifications; Methods of Testing; Recommended Practices; Definitions of Terms; Charts and Tables. December, 1940. 260 S. Broad-street, Philadelphia Pa., U.S.A.: American Society for Testing Materials. [Free.]

Steam Power Stations. By PROFESSOR G. A. GAFFERT. Second edition. London: McGraw-Hill Publishing Company, Limited. [Price 31*s.* 6*d.*]

Aircraft of the Fighting Powers. Compiled by H. J. COOPER and O. G. THETFORD. Edited by D. A. RUSSELL. Leicester: The Harborough Publishing Company, Limited, Allen House, Newarke-street. London: Horace Marshall and Son, Limited, Temple House, Tallis-street, E.C.4. [Price 10*s.* 6*d.*]

The Institution of Production Engineers. Research Department. Accuracy in Machine Tools: How to Measure and Maintain It. A Practical Manual for Production Engineers. By DR. GEO. SCHLESINGER. Edited by D. F. GALLOWAY. London: Offices of the Institution, 36, Portman-square, W.1. [Price 3*s.* net.]

PERSONAL.

The Council of the Institution of Electrical Engineers has made the 19th award of the Faraday Medal to DR. A. P. M. FLEMING, C.B.E., M.Sc., a Past-President of the Institution.

MR. H. C. GODSMARK, A.M.I.A.E., M.Inst.T., who has been general manager and chief engineer of the Huddersfield Corporation Tramways and Omnibuses since 1933, is succeeding MR. T. P. EASTON as general manager of the Newcastle-upon-Tyne Corporation Transport and Electricity Undertaking. We are informed that Mr. Easton is retiring in March.

MESSRS. THE ASSOCIATED EQUIPMENT COMPANY, LIMITED, Southall, Middlesex, have temporarily re-established their Southampton sales depot at 125, Athelstan-road. The telephone number (Southampton 2468) and the telegraphic address (Vangastow, Phone, Southampton) remain unchanged.

MR. D. FISON, engineer of the Harbours and Marine Department, Queensland, Australia, has retired. His services are retained, however, in a consulting capacity.

MR. J. V. GIL, M.I.E.E., late technical director of Messrs. The Kohler Company, Limited, Great Portland-street, London, W.1, has been appointed chief electrical engineer to Messrs. F. Perkins, Limited, Peterborough.

MR. EDWARD HERBERT CLIFFORD, A.R.S.M., consulting mining engineer to the British South Africa Company, has been elected President of the Institution of Mining and Metallurgy for the year 1941-42. He will take office in May.

Inquiries to the Head Office, H.M. Customs and Excise, regarding Purchase Tax should, in future, be addressed to THE SECRETARIES, H.M. CUSTOMS AND EXCISE, City Gate House, 29-45, Finsbury-square, London, E.C.2. (Telephone BIShopsgate 6550.)

MR. J. A. MILNE has been appointed general manager of Messrs. J. Samuel White and Company, Limited, shipbuilders and engineers, Golden Cross House, Charing Cross, London, W.C.2., and has commenced duties with the Company.

MAJOR R. A. B. SMITH, M.C., has retired from the directorship of the Cement and Concrete Association, 52, Grosvenor-gardens, London, S.W.1, as from February 1. He is setting up in private practice as a consultant.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—The activity in the steel trade of Scotland is more pronounced than ever. All classes of consumers are pressing for supplies and most of them are engaged on Government work. The shipbuilding yards are busy, so that the consumption of plates and sections has been on a large scale; boiler plates are also in great demand. Constructional engineers have well filled order books and their requirements amount to a considerable tonnage. There has been no slackening in the demand for black and galvanised sheets, and during the past week it has been increasing, with the result that all plant is running at full capacity. Special grades of steel are in strong request and the demand is increasing. The supply of raw materials is satisfactory. Prices are as follows:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—The improved state, noticeable in the malleable-iron trade of the West of Scotland recently, continues. Fresh orders have been coming in steadily and practically all grades of iron are in demand. The re-rollers of steel bars are extremely busy and are experiencing considerable pressure for deliveries. Supplies of semies have been coming in well and ample stocks are now held. The following are the current quotations:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—There has been no change in the state of the Scottish pig-iron trade during the week and the full output from the furnaces in blast is being maintained. The demands of consumers are pressing and the steel makers, in particular, are taking up all the hematite and basic iron available. Stocks of raw materials are satisfactory, as good shipments have recently been received. The market prices are as follows: Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—While Sheffield works are accounting for increased outputs in connection with the war effort, there is a growing influx of orders for ordinary commercial products; some of the orders are on export account. Many municipal corporations are in the market for a variety of products. Sheffield Corporation Water Committee propose to enter into a contract with Messrs. Stewarts and Lloyds, Limited, Glasgow, for the supply of steel pipes for bridge crossings. The Electricity Committee proposes to accept the offer of Messrs. Mitchell Engineering, Limited, to construct a dock on the River Don at Blackburn Meadows for the delivery of coal from barges; and also proposes to purchase two rectifiers with transformers and switchgear from Messrs. Electric Construction Company, Limited, and one rectifier with switchgear from Messrs. Hewittic Electric Company, Limited. Producers of semi-finished materials have few complaints regarding the progress made, especially in the supply of pig-iron, hematite, and scrap, but steel users are apparently less fortunate. Steelmakers are endeavouring to keep pace with orders, but the demand is so extensive and varied that orders are accumulating. The position, however, is likely to become easier during the next few weeks. The heavy machinery and engineering branches are extremely busy. All types of steelworks and ironworks machinery are in strong demand, especially plant used in the production of engineers' small tools and machine tools. Sheffield works producing grinding and crushing plant are doing a satisfactory amount of overseas trade, particularly with Canada, South Africa, India, New Zealand, and certain of the South American countries. Orders for railway rolling stock are more numerous, but the amount of business being done is below the pre-war standard. Shipbuilding yards are taking increased tonnages of Sheffield-made steel and tools. Large forgings and castings are being manufactured in response to orders from shipyards in various parts of the North of England.

South Yorkshire Coal Trade.—A brisk trade is being done in all classes of coal. Industrial concerns are taking larger quantities of steam-raising qualities and smalls and slacks are in demand for electric power stations. As is usually the case at this time of the year, there is an active market in house coal. Foundry and furnace cokes are steady.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—Following the change that has been made in the control arrangements, whereby exports of coal to Eire have been placed on the same footing as those to other overseas destinations, considerable interest has been aroused in this trade on the Welsh steam-coal market. It was feared by shippers that the result would be a considerable diminution in deliveries to Eire. So far, however, exporters have found that while coal export licences were being issued fairly readily in respect of coal consigned to the railways, considerable difficulty was being experienced in regard to other users. It seemed to be the policy of the authorities to restrict licences in respect of the bituminous grades, which were in keen request from home industrial users, and to grant them only in respect of the dry steam sorts. As a result, shippers were trying to interest their Eircan customers, who previously had taken bituminous grades, in the dry steam kinds and a quiet business was arranged. Eire has been an important outlet for coals, providing a market for some 3,000,000 tons per annum from the United Kingdom as a whole. Practically the only other overseas markets that were showing any activity were Portugal and South America, although some inquiries were received from Spain and Greece. To South America, shipments were proceeding on limited lines, and difficulty was encountered by exporters to Portugal in covering their needs. In this trade, producers still had heavy deliveries to make and buyers were showing close attention. The home trade continued brisk, particularly in respect of the high-volatile bituminous grades, for which there was a keen demand from industrial users. In view of the heavy commitments sellers have already entered into, new business was difficult to arrange for some time ahead. Dry steams were steadier. Best large grades were again a firm feature, and the sized sorts remained scarce and were consequently very firm. The shortage of the bituminous small qualities was acute, but dry smalls were freely offering and dull. Cokes received close attention and were active, but patent fuel was in slow request.

The Iron and Steel Trade.—Very busy conditions again characterised the iron and steel and allied trades of South Wales and Monmouthshire last week. The demand continued to be brisk, and the works, having well filled order books, were kept engaged almost to full capacity.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—The aggregate tonnage output of iron and steel is being maintained at almost a record level and with the increasing flow of imports from the United States, adequate supplies of material for war industries are assured and the prospects of the release of additional quantities of material for the usual commercial undertakings is improving. At the same time, as makers are heavily sold and their outputs are largely allocated for delivery over the first quarter of the year, there is little possibility of placing further orders except for work of special importance. The regulations under the control of distribution scheme are still strictly adhered to and as purchases can only be made under licence, the system has prevented leakages and enabled producers to keep pace with all requirements for essential purposes.

Cleveland Iron Trade.—More scrap than has been available for a considerable time is passing into use at North-East Coast foundries, the increasing activity of which, however, necessitates a substantial additional consumption of pig. Only moderate quantities of Cleveland brands are obtainable, but ample supplies of foundry iron are coming to hand from other producing centres. Deliveries of Midland products are still quite satisfactory and for special specified purposes adequate parcels can be obtained from Scotland and elsewhere. Second hands are handling more tonnage than hitherto, but are anxious to obtain control of larger parcels. The fixed prices for Cleveland pig are based on No. 3 quality at 128*s.*, delivered in the Middlesbrough district.

Hematite.—The substantial production of hematite, supplemented by cargoes of American iron, are barely sufficient for the actual needs of the consumers. The demand continues to expand and there is still little hope that conditions will permit a material enlargement of the make. Imports from the United States, however, are expected to increase sufficiently to cover requirements. New business in East Coast hematite is difficult to transact, but the increasing use of American makes is easing the pressure for the delivery of local brands. The bulk of the output of this area is absorbed by the needs of the makers' own consuming departments, but contracts with those users who are entirely dependent on the market for supplies are quite extensive. As is the case in the Cleveland pig branch of trade, merchants are receiving better parcels than formerly and are able to deal with any urgent needs of their regular customers. The official quotations for local and American hematite are at the level of No. 1 description at 138*s.* 6*d.*, delivered to North of England buyers.

Basic Iron.—Producers of basic iron continue to retain the small surplus output as emergency stock for the requirements of their steel-making plant, and as there is no tonnage for sale, the recognised market value of 120*s.* 6*d.* is nominal.

Foreign Ore.—Imports of foreign ore are better than had been expected and are likely to improve. The dependency on foreign supplies, however, is being reduced by the increasing use of native ironstone.

Blast-Furnace Coke.—Conditions with regard to blast-furnace coke are not conducive to business. Holders have good stocks but are well sold and local users are extensively covered. Quotations for Durham qualities are ruled by good medium sorts at 35*s.* 6*d.* f.o.r.

Manufactured Iron and Steel.—Full activity at the re-rolling mills is ensured by a plentiful supply of semi-finished iron and steel, and the output of manufactured iron is promptly taken up. The substitution of finished iron for steel for several purposes is proving satisfactory. Iron-bar makers have more work in hand than they can deal with and are not accepting further orders for the time being. The production of finished steel is still exceptionally heavy, but large imports are necessary to meet the delivery demands which are unabated. The call for black and galvanised sheets and plates exceeds the output and all classes of special steel are in strong request, but there is a temporary easing of the demand for structural material; shipbuilding specifications, however, are accorded special priority and there is a considerable demand for railway material. Soft steel billets are quoted at 12*l.* 5*s.* per ton; hard billets at 13*l.* 12*s.* 6*d.* per ton; joists and sections at 15*l.* 8*s.* per ton; heavy plates at 16*l.* 3*s.* per ton; and heavy rails at 14*l.* 10*s.* 6*d.* per ton.

Scrap.—Iron and steel scrap is in considerable request although users have substantial stocks. Buyers are endeavouring to place extensive forward orders, particularly for heavy grades of material.

CANADIAN NATIONAL EXHIBITION.—The 1941 Canadian National Exhibition will be held at Toronto from August 22 to September 6. Inquiries regarding the function should be addressed to Mr. G. H. Ward, at the London Office of the Exhibition, British Columbia House, 3, Lower Regent-street, S.W.1.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

JUNIOR INSTITUTION OF ENGINEERS.—Saturday, February 8, 1.30 p.m., 39, Victoria-street, Westminster, S.W.1. Informal Meeting. Lecture: "Papers and Discussions," by Mr. A. P. Morris. *Midland Section:* Saturday, February 8, 3 p.m., The James Watt Institute, Birmingham. Ordinary Meeting. "The Engineer in the Drop-Forging Trade," by Mr. A. Russell.

INSTITUTION OF ELECTRICAL ENGINEERS.—*North Midland Centre:* Saturday, February 8, 2.30 p.m., The Hotel Metropole, King-street, Leeds. "The Application and Use of Quartz Crystals in Telecommunication," by Mr. C. F. Booth. *North-Eastern Centre:* Monday, February 10, 6.15 p.m., The Neville Hall, Westgate-road, Newcastle-upon-Tyne. "Electricity in Paper Making," by Messrs. W. G. Mason and S. A. G. Emms.

INSTITUTION OF AUTOMOBILE ENGINEERS.—*London Graduates' Branch:* Saturday, February 8, 3 p.m., 12, Hobart-place, S.W.1. "Production Organisation," by Mr. D. H. Bramley.

BRADFORD ENGINEERING SOCIETY.—Monday, February 10, 7.15 p.m., The Technical College, Bradford. "Some Common Types of Water Supplies and Their Influences in Steam Plant," by Messrs. W. F. Gerrard and T. Millican.

ILLUMINATING ENGINEERING SOCIETY.—Tuesday, February 11, 2.30 p.m., The E.L.M.A. Lighting Service Bureau, 2, Savoy-hill, W.C.2. "The Recognition of Coloured Light Signals," by Mr. J. G. Holmes.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, February 11, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Experiments in Rough Water with a Single-Screw Ship Model," by Messrs. J. L. Kent and R. S. Cutland.

ROYAL SOCIETY OF ARTS.—Wednesday, February 12, 1.45 p.m., John Adam-street, Adelphi, W.C.2. Ordinary Meeting. "Humus and the Farmer," by Mr. G. V. Jacks.

NEWCOMEN SOCIETY.—Wednesday, February 12, 2.30 p.m., The Institution of Civil Engineers, Great George-street, Westminster, S.W.1. (i) "Early Application of Engineering to the Warming of Buildings," by Mr. A. F. Dufton. (ii) "History of the Hydraulic Extrusion Process for Metals," by Mr. C. E. Pearson.

INSTITUTION OF ENGINEERS-IN-CHARGE.—Saturday, February 15, 2 p.m., The E.L.M.A. Lighting Service Bureau, 2, Savoy-hill, W.C.2. Lecture: "Recent Developments in Electric Lamps and a Review of A.R.P. Lighting Practice," by Mr. R. Pelerin.

CONTROL OF CAUSTIC POTASH AND POTASSIUM CARBONATE.—The Minister of Supply has made an Order, entitled the Control of Caustic Potash and Carbonate of Potash (No. 2) Order, 1941. Under the new Order which revokes the (No. 1) Order previously in force, the purchases for consumption of caustic potash and carbonate of potash which may be made by any one person, without licence, are now restricted to lots not exceeding, in the aggregate, 5 cwt. a month. In the case of purchases of liquid potash, the corresponding amount is 13 cwt. a month, of material not exceeding 55 per cent. KOH. It is probable that, in future, caustic potash will normally only be available in the liquid form. Applications for licences to purchase quantities in excess of those named should be made to the Secretary, Raw Materials Department, Ministry of Supply, The Castle, Warwick. The envelope should be clearly marked "Caustic Potash," or "Carbonate of Potash," according to the material required.

HOME GUARD MANUAL.—We have received from Messrs. The Ruberoid Company, Limited, Meadow Mills, Stonehouse, Gloucestershire, a copy of a 48-page booklet, *The Home Guard Pocket Manual*, by Regimental Sergeant-Major A. Southworth, containing, in a condensed form, the main elements of drill, weapon training and field training as required to be practised by the members of that force. The booklet, which is sold at the price of 6*d.*, and has been compiled from the larger official manuals, has the incidental object of indicating possible uses for Zylex reinforced felt, Pluvex felt and Ruberoid roofing in the construction of defence works; but this purpose is not over-emphasised, being confined to a separate section illustrating "Some Practical Field Hints." The musketry section contains eight pages of excellent half-tone illustrations, and also a note on the origin of the Enfield (not Lee-Enfield) Pattern 1914 rifle which should dispose finally of the various erroneous identities that have been attributed to its offspring, the "P.17" rifle, with which the Home Guard are now armed.

THE "BOTHA" I GENERAL RECONNAISSANCE AND TORPEDO BOMBER.

MESSRS. BLACKBURN AIRCRAFT, LIMITED, BROUGH.

(For Description, see page 107.)

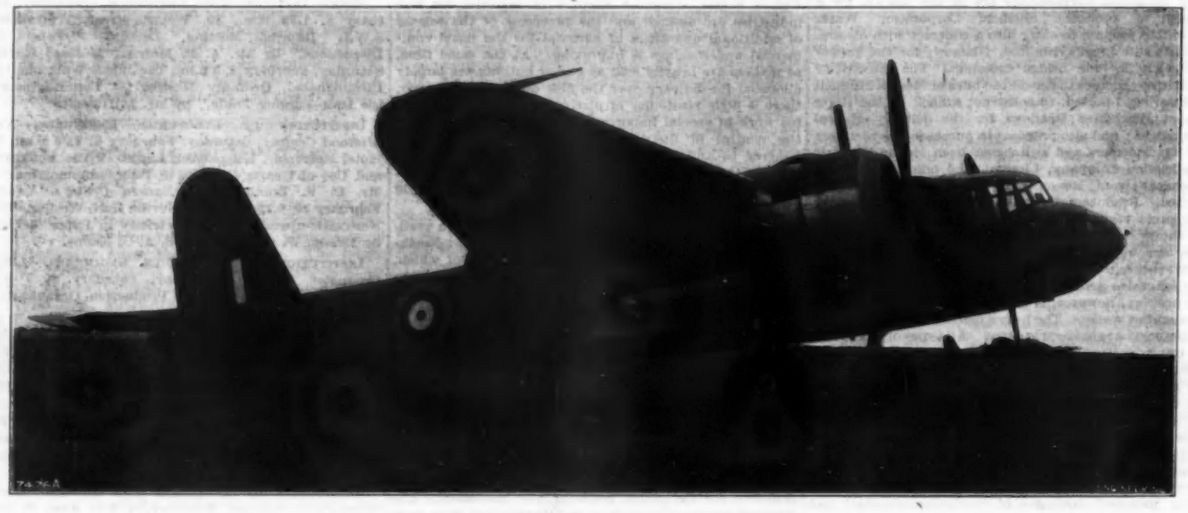


FIG. 1.

FIG. 2.

ARTIFICIAL LIGHTING OF FACTORIES.—The National Industrial Electric Lighting Service is an organisation founded by the electrical industry to facilitate the carrying out of the regulations based on the Fifth Report on Factory Lighting, and to place a complete service, for which no charge is made, at the disposal of factory owners and executives. We are informed that in the northern counties those requiring advice on this subject should apply to the Local Secretary, National Industrial Electric Lighting Service, 47, Pilgrim-street, Newcastle-upon-Tyne.

MOTOR LIFE-BOATS FOR BRITISH SHIPS.—The Ministry of Shipping recently decided that every British ship of over 2,000 tons must carry at least one power-propelled life-boat, and has now placed an order with Messrs. Morris Motors, Limited, Cowley, Oxford, for five hundred 6/12-b.p. Vedette petrol engines, together with incidental equipment, including propeller, steering gear, and two 10-gallon petrol tanks for each boat. It is stated that the Vedette engine has a petrol consumption of ¼-gallon per hour when propelling a 26-ft. life-boat at a speed of 5 knots. This will give the boat steerage way for about 24 hours and a radius of action of approximately 110 miles, which could be increased by conserving petrol by spells of pulling or sailing. Moreover, a simple motor life-boat will be able to tow a number of oar-propelled boats or rafts.

DIESEL-ENGINE DRIVEN GENERATING STATION AT PORT MACQUARIE.—To cope with the demands of its rapidly increasing population, a new electric-generating station has been installed at Port Macquarie, which is a seaside town at the mouth of the Hastings River, New South Wales, Australia. The power is supplied by three Diesel engines furnished by Messrs. Blackstone and Company, Limited, Stamford, Lincs, directly coupled to alternators having a combined output of 500 kW. Two of the engines are 240-b.h.p., six-cylinder units and the third is a 120-b.h.p., three-cylinder engine. The engines are of the latest totally-enclosed design and, as the plant has to run unattended for part of the day, an alarm system has been installed. This, we understand, gives complete protection against accidents, such as an excessive rise in the lubricating-oil temperature, failure of the cooling-water flow, overspeed or overloading, failure of the oil pressure and excessive temperature of the cooling water. If the alarm is not attended to within five minutes, the engine automatically stops and no damage is done. The engine room measures 70 ft. by 31 ft., and a special fuel room is provided, the fuel entering the engine room through a trench which also accommodates the air, lubricating-oil, and cooling-water pipes.

ENGINEERING.

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We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and other publications bearing somewhat similar titles.

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ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING," Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

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ENGINEERING

FRIDAY, FEBRUARY 7, 1941.

VOL. 151. No. 3917.

THE FUTURE OF APPRENTICESHIP.

VARIOUS official hints have been dropped, in recent weeks, regarding the Government's intentions to overhaul the whole educational system of the country as soon as possible after the war. The immediate extension of the school-leaving age to 15 by Order in Council is envisaged as a first step, with a probable eventual increase to 16 as a feature of a comprehensive new Education Act, the exact scope and effect of which depend upon the recommendations of a Royal Commission or other committee of inquiry. One of the many developments that are expected to be included in the programme is a considerable expansion in the provision of junior technical schools, the value of which has been so widely demonstrated since the first establishment of this kind was opened in Liverpool nearly 40 years ago. These plans are encouraging indications of a definite policy to aid the skilled trades to repair their normal numerical wastage, and to do so with material of tested quality.

Whenever schemes are propounded for the improvement of elementary education, however—and especially the education of those, most of whom must obviously become and remain manual wage-earners—it is natural to inquire what effect the proposed change is likely to have on the all-important period of apprenticeship that is to follow. Some trades are unavoidably lacking in attraction and already have found difficulty in obtaining a satisfactory proportion of recruits: the case of the foundry trade, in particular, was the subject of a valuable but distinctly disturbing report by one of H.M. Inspectors to the Board of Education so long ago as 1924. "It is generally agreed," stated this report, "that there is a lack of suitable entrants which is so pronounced in character as seriously to menace the future development and prosperity of the industry." The problem of how best to ensure a sufficient flow of trade apprentices of what may be termed "ordinary" capabilities, while providing every opportunity of advancement for the small proportion of entrants who are capable of greater attainments and can be offered a reasonable expectation of securing and retaining the higher executive posts, has given rise to much discussion in the past; together with many "Letters to the Editor" on the organisation of the Royal Dockyards, which seem to have solved it very satisfactorily. There are other methods, of course, such as that of the Metropolitan-Vickers Electrical Company, which Dr. A. P. M. Fleming has described on various occasions. Most of them, however, are suited to a large establishment rather than to one of small or even medium size; and when they have been discussed at institution meetings, there has usually been some inquirer to ask how this almost ideal state could be adapted to fit in with the needs and the capacity of the small works, probably employing no more than a few score persons all told. A suggested method by which this could be achieved, if necessary on a national scale, is outlined in the article by Mr. Cyril J. Atkins which we print on page 115 of this issue.

It will be gathered from Mr. Atkins' proposals that the programme indicated is merely tentative, and is intended rather to illustrate the principle rather than to lay down a hard and fast curriculum. In some respects, it might be modified to suit local requirements or to enable fuller advantage to be taken of local facilities. We should be inclined to suggest, too, that the option afforded, in the case of drawing-office time, of spending this period either in a Government training centre or in a works, might be extended to the acquisition of forge, foundry and pattern-shop experience, or else that a portion of this time might be spent in each *milieu*; there is an interest in the performance of actual productive work that no mere instructional exercise can hope to equal. Such points as these, however, can only be settled after a more detailed consideration than is practicable in the preliminary stages. A certain amount of flexibility in the time-table would probably prove desirable, to permit of adjustments to suit individual cases; some apprentices would be sure to display particular aptitudes or limitations at a comparatively early stage, for which proper allowance should be made, and we should expect the majority to exhibit a definite bent long before reaching the last six months of the training, when Mr. Atkins expects such "latent abilities and inclinations" to become obvious.

It is of interest to compare this suggested programme with that proposed in 1919 by the Engineering Training Committee appointed by the Liverpool Engineering Society "to consider and report . . . as to the educational facilities of the district, and to suggest the best means of co-ordinating these and the local engineering establishments." This committee, which was primarily concerned with the case of trade apprentices, declared a definite belief that "the old idea of the single educational ladder is wrong; and that the right method . . . is to have several educational ladders, leading respectively to various altitudes of educational attainment, each ladder being proportioned for and adapted to the height to which it ascends; and while every facility should be afforded for the exceptional cases of proved ability to change ladders at definite stages, the ladders reaching the highest positions should not be overcrowded on the lower rungs by those manifestly unfitted to accomplish the complete ascent."

The committee recommended that no boy should begin his apprenticeship before the age of 16; that, from the age of 12 to 14 (when his mechanical bent, if any, should be evident) he should attend either a secondary school or, preferably, a junior day technical school, where his studies could be directed into the appropriate channels; that training between the ages of 16 and 18 should be on the part-time system, between the works and technical schools; and that, after the age of 18, further schooling should be optional, by means of evening classes at the technical schools or the university. In the case of those wishing to proceed to a university degree, three years in the works should be deemed sufficient. Exceptional boys might do so well at the technical schools that this period might count as part of the degree course, enabling them to take the degree in two years, provided that they had matriculated not less than a year before entering the university. Engineer apprentices (as distinct

from trade apprentices) entering the works from secondary schools, between 16 and 18, were expected to pass matriculation or an equivalent examination before doing so.

In several respects, the proposals were somewhat in advance of the time, though they showed a conservatism which may be regarded as healthy in that they did not seek to make the way of the apprentice too easy. Without desiring in any way to perpetuate the practices of an era which looked upon apprentices merely as cheap labour, probably the majority of engineers whose apprenticeships date back before the last war would admit that the hard grind of 53 or 54 hours a week, plus evening classes, possessed a definite tonic quality, and that they suffered no physical harm from it; though, in many cases, their theoretical work may have been accomplished less rapidly than would have happened under a part-time system. Mr. J. E. Lloyd Barnes, who suggested the appointment of the committee whose report is quoted above, expressed his own emphatic belief that "the tendency to make work easy and pleasant by avoiding all that involved grind and hard work was a bad preparation and discipline for the hard realities of business life"; a point of fundamental fact that has been very little affected by the social and industrial changes that have taken place in the 22 years that have elapsed since it was made.

The origin of apprenticeship, there is little doubt, lay in a desire to preserve a monopoly; but it is a cardinal point in economics that monopolies contain in themselves the germ that leads to their eventual disruption. The modern urge is all for equality of opportunity, a principle with which no fault can be found provided that it is not made the excuse for attempts to enforce an equality of the human product which is as contrary to Nature as it is unsuited to the infinitely varied needs of civilisation. In the introduction of any standardised common scheme for the production simultaneously of recruits for all branches of the engineering industry, manual, supervisory and directive, there are two principal dangers to be avoided: one is that of allowing vested interests to impede the free transition of aspirants from one ladder to another (to use the metaphor of the Liverpool committee) or to begrudge them the reward of their efforts when they have reached the top; and the other is that of forcing the flow through the educational machine merely for the purpose of keeping it in operation at some desired load factor, which would only result in creating a discontented "intelligentsia" for which there is no real need and, therefore, no assurance of appropriate employment.

The first of these dangers appears to be almost a part of human nature, but there is no reason why it should continue to be, at least, to the same extent, if the inflow to the engineering industry becomes less haphazard, so as to offer a reasonable chance to every entrant who is prepared to work steadily and take full advantage of the facilities available for advancement. The reality of the second danger is sufficiently illustrated in the case of India, which, together with other countries, has produced engineering and other university graduates far in excess of immediate requirements. There have been frequent suggestions that the saturation point has been reached in this country also; but this we do not believe, although it may have been true at times that the supply of college-trained men was increasing more rapidly than the appreciation by the heads of industry that these men might prove useful in their organisations. It is to be hoped, too, that local enthusiasts in educational matters will not press unduly the attractions of the National Certificate, to the extent of overloading with bookwork lads who are temperamentally unfitted for it. A poor theoretical man gained is no compensation for a good practical man lost; and one of the major aims behind any such reorganisation as is contemplated by the educational authorities, and envisaged by Mr. Atkins, should be, that the British engineering employer of the future shall have no occasion to write as James Watt did to his representative in Cornwall: "Get some sober man to attend the engine, some man of common gumsion, though not a professed engine-man."

WOMEN IN INDUSTRY.

ALTHOUGH the employment of women in industry is a topical subject, around which much discussion is revolving, it is no new phase of activity. The conditions under which women were working in the cotton mills of Lancashire were the main cause of the enactment of the first factory laws. In the Nineteenth Century the employment of women gradually came to be associated with particular industries and, in general, the textile trades were considered to be women's work. A War Cabinet Committee reported that, even as recently as July, 1914, only 170,000 women were employed in the metal industry, as compared with 1,623,000 in the paper, printing, textile and clothing trades. This committee, which was set up in September, 1918, presented a report on Women in Industry in April, 1919. As in that report it was stated that 2,000 women were employed in Royal Ordnance Factories, that number should probably be added to the 170,000 accredited to the metal industry. This, however, does not affect the comparison with July, 1918, to any material extent. At that date the number of women engaged in the paper and textile industries had decreased by 86,000, but those in the metal industries and Royal Ordnance Factories had increased by 647,000.

As, in engineering circles, "the metal industry" suggests Sheffield and the North-East Coast, it will be more convenient to refer to what the War Cabinet Committee called the metal industry, as the engineering industry. In the last war, women were engaged on operations of many kinds, some of them of a rather unsuitable type, so that the 647,000 who entered the industry between July, 1914, and July, 1918, were spread over a large part of the engineering field. If a census had been taken in September, 1939, it would have shown a very much larger figure than the 172,000 of 1914, but this would not have been because women had retained the positions in any and every branch of engineering which they had secured as a result of war conditions; it would have been due to the great developments which have taken place in the lighter engineering trades during the past 20 years. In a paper read before the Royal Society of Arts on January 15, Miss Caroline Haslett (who quoted the figures from the War Cabinet Committee which are given above) suggested that one reason why women had taken such a large place in the lighter, mainly new, engineering industries was that, in these, they were not hampered by the existence of "a tradition of men's labour," as they were in the older engineering trades. In electrical engineering, although women had established a position in the making of the lighter components, they had not succeeded to a corresponding extent in those sections of it which were closely allied to mechanical engineering, and which "were affected by the traditions of that trade."

This point of view is of interest, but it is doubtful if the great influx of women into, say, the electric-lamp industry is to be explained mainly by the fact that they started level with men, and that there was no tradition that any individual process was the prerogative of some particular men's trade union. Certainly, trade unions are jealous of the position and traditions they have built up, and do all that they can to prevent any type of industrial operation from passing out of the hands of their members; that is one of the reasons for their existence. None the less, had electric lamps been manufactured on an important scale fifty years ago, so that a male lamp-makers' union had become established, it is not likely that women would have been prevented from obtaining the place in that industry to which they have attained.

The reason that women are employed so largely in the lighter electrical industries is that, in general, these are suited to their physical strength and are mass-production activities in which it is economically feasible to subdivide the manufacture to such an extent that it becomes a series of relatively simple operations. The numerical scale on which such parts are made also renders it possible to develop and use special machines and special jigs, each designed to assist only one operation, usually a simple one. No better illustration of this could be found than in a modern electric-lamp factory. If such an establishment could be imagined with no special machines and the operatives making complete lamps, not merely parts of lamps, with hand tools, it would be clear at once that it is the subdivision which has turned a skilled man's trade into an occupation for semi-skilled women.

As examples of new industries in which there is not "a tradition of men's labour," Miss Haslett gave automobile, electrical and aeroplane construction. On her theory, women should have taken the same position in motor-car building that they have done in the manufacture of electric lamps. Actually, of course, they have done nothing of the kind. As was shown in the last war and as is being shown in this, women are capable of carrying out a large proportion of the machining operations which go to the building of a car engine, but a walk through any motor-car factory in 1939 would have made it clear that they have not done so. The main reason for this is probably their lack of physical strength. Under war conditions, women have operated relatively heavy machine tools for months or even years on end, but that is not to say that, under normal conditions, they are capable of continuing in such work indefinitely, or even that they are prepared to do so. The position which women have established in the lighter electrical and mechanical industries they will continue to hold, but this is no justification for indulging in false hopes about new industrial fields which they are to conquer in this war. Manufacturing developments may gradually increase the range of work on which they may be employed, but there is no reason to suppose that, when peace returns, they will continue to follow occupations for which they are not physically suited.

Miss Haslett made a further interesting suggestion to the effect that "the breaking down of processes into their components," so that manufacture could be carried on by semi-skilled labour, had been influenced by "the necessity of the war years." It may well be that the industrial position in 1914-1918 gave many manufacturers, who had previously employed only skilled men, such experience of the possibilities of breaking down complicated operations that it influenced their post-war practice. It would be a mis-reading of industrial history, however, to suppose that such subdivision was in any sense introduced by war conditions. In essence, such simplification has existed for hundreds of years and had reached a high state of development in many industries long before the advent of the last war. It would be a poor tribute to the great contribution to manufacturing technique which has been made by Henry Ford to suggest that the war of 1914-1918 afforded the first clear demonstration that the subdivision of a machining or assembling operation into its elements would enable a skilled-man's product to be made by a team of unskilled persons.

The great influx of woman labour into the engineering industry has been due essentially to the enormous increase in the trade in consumption goods. Electric lamps have been mentioned. To them may be added wireless sets, gramophones, domestic appliances of all kinds, bicycles, a wide variety of containers, motor-car fittings, and so on. The instrument trades, like the watch industry of Switzerland, have also absorbed large numbers of women. These industries are not only of a light character, but embody the essential condition that repetition manufacture can be carried on on a very large scale. The prosperity of industries of this kind is largely a function of the standard of living and, to the extent that, after the war, the country is able to afford what are in essence mainly luxuries, so the employment of women in the engineering industries may be expected to continue and possibly to increase. It does not follow, however, that the manufacture of consumption goods of a heavier class—of which motor cars are the best example—will be undertaken in the future by women. They have shown, and are showing in the shell factories or other munition plants, that they can operate the machine tools required for that work, provided simplification of operations is carried far enough; but this occupation is not generally suited to their constitution, and it is not economically or socially desirable that they should attempt to adopt it permanently.

NOTES.

SIR ANDREW DUNCAN.

SINCE its foundation, just seventy years ago, the Institution of Electrical Engineers has conferred the distinction of honorary membership on forty-six persons. For the past thirty years election to this honour has been at the rate of one a year, and before then at longer intervals; on the other hand, there was sometimes more than one addition to the list in a single year. The recipients have been mainly electrical engineers or physicists and have been generally drawn from among the ordinary members of the Institution; to this rule, however, there have been notable exceptions. In 1876, Frank Ives Scudamore, who was a distinguished Post Office official and who negotiated the acquisition of the telegraphs by the Government between 1865 and 1870, was elected honorary member, having already served as president in 1873, while others included in the ranks were Edward Davy, a surgeon, and Jacob Brett, of Atlantic cable fame. Coming to more recent years, Lord Southborough, who gave great assistance in obtaining a Royal Charter for the Institution in 1921, is another non-electrical honorary member. To these have now been added the Right Honourable Sir Andrew Duncan, the Minister of Supply, and electrical engineers will welcome a gesture which fittingly honours one who, though not an engineer himself, has done much to assist the development of the electricity supply industry. When Sir Andrew was appointed chairman of the Central Electricity Board in 1927, it is probable that he was hardly known to the profession, though he had done useful work as Coal Controller just after the end of the last war. In this appointment Sir Andrew was faced with a difficult task. The idea of re-organising the electricity supply industry on voluntary lines, which was enshrined in the Electricity (Supply) Act of 1919, had failed and the Act of 1926 imposed a measure of compulsion which was no more popular than such methods usually are. The necessary changes could, therefore, have been brought about by force. Sir Andrew, however, ably assisted by Sir Archibald Page, took the wiser course of making every attempt to secure agreement by diplomacy and it is apparent that his policy was almost completely successful. When he resigned the chairmanship of the Central Electricity Board in 1935, a great deal of pioneer work had been done with a minimum of friction and the machinery was, generally speaking, working smoothly. Since then Sir Andrew has been chairman of the Executive Committee of the British Iron and Steel Federation, entering the Government as President of the Board of Trade in the spring of last year and being transferred to the Ministry of Supply at the latest reconstruction.

INDUSTRIAL RADIOGRAPHY.

A conference on industrial radiography was held by the London and Home Counties Branch of the Institute of Physics in the library of the Research Laboratories of Messrs. The General Electric Company, Limited, on January 25. The conference, which was presided over by Dr. V. E. Pullin, C.B.E., radiological consultant to the Aeronautical Inspection Department, was attended by nearly 100 representatives from various industries in this country. Three short papers were communicated, namely, "Applications of Radiography to the Electrical Industry," by Mr. H. P. Rooksby and Miss K. L. Jackman (The General Electric Company, Limited); "X-Ray Examination of Light-Alloy Castings," by Mr. W. L. Harper (Aeronautical Inspection Department); and "Recent Developments in the Photographic Aspects of Radiography," by Dr. L. Mullins (Kodak, Limited). After the papers had been read, Dr. Pullin reviewed the whole subject and, in the course of his commentary, he pointed out the necessity of achieving pre-eminent technique if the interpretation of the photographs taken were to be of real value. It was necessary, however, to bear in mind the limitations of radiography as well as its capabilities. The proper place for the radiographic equipment was in the foundry itself, whether the material examined were a steel or a light alloy. Furthermore, it was important to select carefully the position of the metal in relation to the apparatus, so as to avoid the superimposition of shadows which were liable to mask defects. It was, in general, unsatisfactory to place photographic films inside cavities in the material. Dr. Pullin also referred to the importance of planar radiography and to the improvement of apparatus for this work; to the possibility of using radon in order to avoid broad focusing effects in radium radiography; and to the recent significant advance made on the photographic side of radiography and the construction of suitable intensifying screens. The discussion at the meeting brought to the fore many important and interesting points, and advantage was taken of the occasion to take preliminary steps to form a Radiography Club. This would provide facilities for industrial physicists to meet at frequent intervals to discuss practical aspects of industrial radiography.

WAR DAMAGE TO ROADS.

Roads are to be included in the property for which compensation is to be payable when it is subjected to war damage, if a new clause in the War Damage Bill, which the Chancellor of the Exchequer is to bring forward, is accepted. The clause proposes that where damage is done to public highways—or to bridges or viaducts carrying them—payments shall be made to highway authorities by the War Damage Commission in accordance with a scheme to be prepared by the Treasury. Contributions towards the expense of such payments shall be made by county and county borough councils at such rates as may be provided in the scheme. The contributions will be payable in five annual instalments and will be in proportion to the rateable value of the property in the area. It is also proposed to give the Minister of Transport power to make grants to councils in respect of their contributions under this war damage scheme. Such grants, which will be paid from the Road Fund, must not exceed one-half of the contributions payable by any council. The scheme to be prepared under this new clause is to be embodied in an Order which will not be effective until it has been approved by a resolution of the House of Commons. There is also to be submitted to the House of Commons a money resolution by which the grants payable from the Road Fund to local authorities under this scheme are to be met from funds allocated by Parliament.

FIRE PREVENTION DUTIES AT THE PREMISES OF ELECTRICITY UNDERTAKINGS.

The Electricity Commissioners have issued a circular calling the attention of electricity supply undertakings to their obligations under the fire-watching orders as regards their business premises. It is pointed out that the Electricity Commissioners have been appointed the "appropriate authority" for this purpose, and that the London Civil Defence Region has been designated a "prescribed area." Fire-prevention arrangements at the business premises of electricity undertakings in this area must, therefore, ensure the presence at all times of an adequate number of watchers, the allocation of specific duties among them, and the availability of adequate equipment to enable their duties to be discharged. The objects in view will be to observe and report the fall of incendiary bombs and to extinguish the fires caused by them. For the first purpose, a party of at least two, and for the second at least three, persons will be required. Watchers should be usually posted on the roof or top floor, but, if it is possible to provide one, a post 20 ft. above the surrounding roofs can cover an area with a radius of 100 yards, provided the watchers can communicate readily with the fire party. A suitable scale of provision for fire parties is one for each 8,000 sq. ft. of total rood area measured on a plan. In large industrial premises watchers, provided they have a full view of all the roofs below them and can communicate with the fire parties by telephone, can cover an area with a radius of a quarter of a mile. The number of fire parties needed will depend on the class of risk, but as a general rule one party of three will be required for areas up to 8,000 sq. ft., two parties of three up to 20,000 sq. ft., three parties of three up to 50,000 sq. ft., and one additional party of three for each extra 50,000 sq. ft. Where undertakings have premises in buildings in which there are other occupiers, joint arrangements may be made and should be notified to the Commissioners. Where there are isolated unattended sub-stations, however, it may be impossible to make arrangements for the attendance of staff for fire-prevention duties, and in such cases undertakings may, with the approval of the Commissioners, be relieved of their obligations. Key men required for emergency work may be exempted from fire-watching duties. Exempted persons may, however, co-operate on a voluntary basis, as also may women members of the staff. All undertakings should at once review the adequacy of their fire-fighting equipment in the light of recent experience of hostile attack, and the Commissioners should be advised what further equipment is needed.

ELECTRIC TRACTION IN SOUTH AFRICA.

The report of the general manager of the South African Railways and Harbours for the year ended March 31, 1940, gives some interesting information regarding the position on the electricity operated sections of the system. Though the extension of this method of working on the old Natal main line proceeded during the twelve months, the war had a retarding effect on its progress. About 50 per cent. of the steel work has been erected, but owing to the difficulty of obtaining material and equipment it has now been decided to suspend the work with the exception of the sub-station buildings, which, until they can be utilised as intended, will be employed for the storage of material. Early in the year under review the 88-kV line between Congella power station and Booth sub-station was completed in record time. The electrification of the Rand mineral line was also completed and the whole of the Witwaterstrand suburban passenger service is now electrically operated. With the electrification of the Pretoria West yard, the scheme for working goods over the Braamfontein-Pretoria-Pretoria West line is complete, except for the energising of the fifth track between Germiston and Johannesburg. The electrification of the Elsburg marshalling yard has also been finished and forms the first portion of a scheme to convert three important yards from steam traction. At August 15, 1940, there were 582 route miles, equivalent to 1,190·5 track miles, worked by electric traction in the Union, and some 35 miles are in course of conversion. The operation of these lines involved the consumption of 370,281,811 kWh, compared with 319,467,124 kWh in 1938-39, an increase of nearly 16 per cent. The total cost was 732,216*l.*, an increase of 8·8 per cent. on the previous year. Among the other developments during the year was the completion of the electric interlocking signalling system at Johannesburg. This is worked on the route relay principle, control being effected by switches and push-buttons mounted on a track diagram. These switches and buttons set up the route, the operation of the points and signals being effected automatically. Similar systems are in course of construction at two other stations. During the year the experimental department designed a train-signalling bell with a view to obtaining clearer signals. This, it is stated, will reduce battery power consumption by 75 per cent.

THE MERCHANT NAVY AT WAR.

In the course of an address to a meeting of the Royal Empire Society, on Tuesday, February 4, the Minister of Shipping (Mr. Ronald Cross) said that at the present time our losses in merchant shipping were in excess of our replacements. In the course of 1940, they amounted to 4,300,000 tons. Those in the worst year we had ever known, namely, 1917, amounted to 6,000,000 tons, indicating plainly enough that the submarine menace was only overcome because our protection to merchant shipping was paralleled by new building on a huge scale. In that respect, the situation had not changed. Assuming an adequate force of naval craft and aircraft, he believed that the level of activity of the submarine could be reduced to a point at which ship losses were less than ship launchings. He looked forward to that time with confidence, but the intervening period would be a hard struggle.

OBITUARY.

DR. H. S. HELE-SHAW, F.R.S.

ALTHOUGH the late Dr. Hele-Shaw was a professor of engineering, or director of technical education, for a period approaching half of his long and active career, it is as an inventor rather than a teacher that his name is likely to be remembered. What may justly be called his genius lay in the direction of mechanism and mechanical things. Of this native ability he made good use and leaves behind him a remarkable record of mechanical innovations which, in addition to novelty, carried the hall-mark of practicability; many were the subjects of very profitable patents. His essential interest was clearly displayed when he was Harrison Professor of Engineering at University College, Liverpool. The lectures which he personally delivered were almost confined to the subject of mechanism. Kennedy's *Kinematics of Machinery*, a translation of Reuleaux's work, formed their basis. As he had made the subject particularly his own, it was natural that Professor Hele-Shaw should choose to deal with it for himself, and there can be no doubt of his personal interest in the matter. Many of his students, however, thought he devoted an undue amount of their time to it. That they had some justification is shown by the fact that few people pay much attention to Reuleaux's mechanical analysis at the present time.

Henry Selby Hele-Shaw, who died on January 30, at the age of 86, was born at Billericay, in Essex, on July 29, 1854. He was educated privately, and at the age of seventeen was apprenticed for four years under Messrs. Rouch and Leaker, at the Mardyke Engineering Works, Bristol. Leaving this firm, he was then engaged for a few months with Messrs. G. K. Stothert and Company. His short connection with this latter firm was explained by the fact that, in 1876, he was awarded the Senior Whitworth Scholarship and with it proceeded to University College, Bristol. This early success, which had much influence on Hele-Shaw's subsequent career, was based on a sound education in his earlier years, evening study and natural ability. His progress at college was striking, and he took full advantage of the rules of the Whitworth awards as they existed at that time. In 1877, he gained a Second Whitworth Prize of 60*l.*; in 1878, a First Whitworth Prize of 100*l.*, and repeated this achievement in 1879. As a result of these successes, he was awarded a Final Whitworth Prize of 200*l.*, as the student who had obtained the highest marks in examinations while holding a three-years' scholarship. In all, he gained awards totalling 760*l.* in Whitworth competitions. A few years ago, Dr. Hele-Shaw gave an amusing account of this part of his career at a meeting of the Whitworth Society, explaining how he began, at the end of each year, to look around for new financial worlds to conquer. He condoned with scholars of the present day in that new regulations had interfered with activities of this kind. During this period, he was also awarded the Miller Scholarship of the Institution of Civil Engineers, for a paper entitled "Small Motive Power." This was the first of a long series of papers presented to scientific and technical societies. The scholarship had a value of 120*l.*

It is not surprising that, after this brilliant start, Hele-Shaw was offered an appointment as Lecturer in Mathematics and Engineering at his own college.

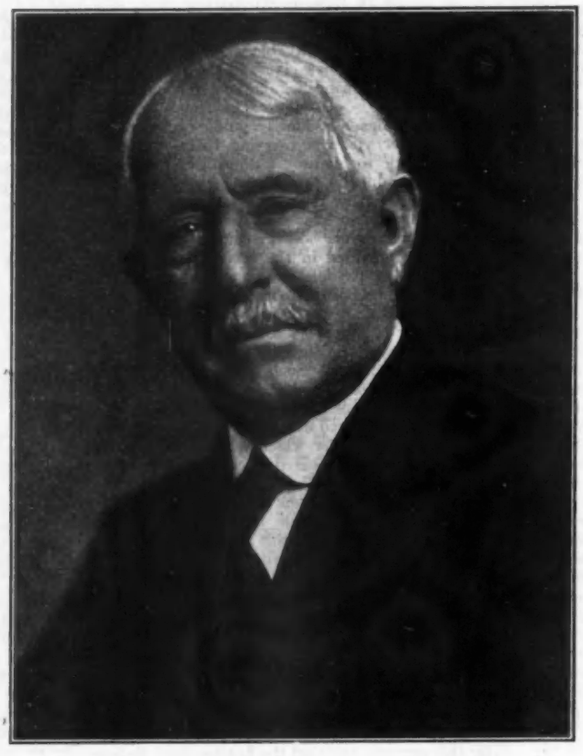


Photo: Elliott and Fry.

THE LATE DR. H. S. HELE-SHAW, F.R.S.

He accepted this post and held it until 1881, when he was promoted to the position of Professor of Engineering. He occupied the Chair, however, for only four years, as in 1885 he was appointed first Professor of Engineering at University College, Liverpool, at that time a constituent college of Victoria University. Before dealing with Hele-Shaw's work at Liverpool it will be of interest to note that, during his professorship at Bristol, he displayed some interest in meteorological matters, a subject which, as far as we know, he did not continue to study in later years. His second contribution to a learned society was a report to the British Association on "A New Integrating Anemometer," in 1881. The instrument concerned, which was of his design, was afterwards made with the aid of a grant from the Royal Society and was installed at Liverpool Observatory. He also read a paper on wind measurement before the Bristol Naturalists' Society. It would probably be true to say that Hele-Shaw's greatest contribution to engineering education in Liverpool was the successful efforts he made to obtain funds and support for the proper endowment of his department. When he accepted the post, the professorship was operating under a temporary guarantee, but, largely owing to his efforts, within a comparatively few years not only had the professorship been properly established, but 25,000*l.* had been spent in the erection of the Walker Engineering Laboratories. As a college lecturer, Hele-Shaw had all the breeziness and humour which later became known to wider audiences, and their effect in the class room was not always conducive to serious study of the subject of the lecture. His sessions were sometimes decidedly hilarious. As already mentioned, he also tended to specialise on his particular subject of kinematics.

It was at Liverpool that Hele-Shaw carried out his investigational work on streamline flow, which brought him wide fame. His experimental methods, by which he reduced a complicated three-dimensional problem to a tractable one in two dimensions, were an excellent example of his mechanical genius. Confining liquid flow between two glass plates set closely together, he was able to examine its behaviour as it met obstacles of various shapes and to investigate the conditions under which turbulence set in. The concept of streamline flow has now become a commonplace of engineering and the adjective has been freely adopted by the public generally, usually being misapplied, but when Hele-Shaw carried out his fundamental work, the phenomenon was novel even to scientific circles. It was for this investigation that he was elected a Fellow of the Royal Society in 1899. His first paper on the subject appears to have been read before the Liverpool Engineering Society in 1897, entitled "Experiments on the Flow of Water." He dealt with the same matter in a paper read before the Institution of Naval Architects in the same year, this being followed by other papers before the same Institution in 1898 and 1900, the latter dealing particularly with balanced rudders. Other papers were presented to the British Association and the Académie des Sciences, and the matter formed the subject of a Friday Evening Discourse before the Royal Institution in 1899. Hele-Shaw's streamline method was also used in the investigation of the distribution of flux in magnetic bodies. In this aspect of the matter he was assisted by the late Dr. Alfred Hay, at that time Lecturer in Electrotechnics at University College, Liverpool. A joint paper, by Hele-Shaw and Hay, on "Lines of Induction in a Magnetic Field," appeared in the *Philosophical Transactions* of the Royal Society in 1900. The same authors, with Mr. P. H. Powell, read a paper on "Hydrodynamical and Electro-

magnetic Investigations Regarding the Magnetic-Flux Distributions in Toothed-Core Armatures," before the Institution of Electrical Engineers, in 1904.

It was while at Liverpool that Hele-Shaw began the type of activity which ultimately occupied the whole of his time. He there designed his well-known multiple-disc clutch, which was made in large quantities. It was described in a paper read at the Summer Meeting of the Institution of Mechanical Engineers in 1903. He was much interested in the question of friction and delivered four Cantor Lectures on the subject in 1886. It was while at Liverpool also that his interest in road transport developed, and in 1897 he organised the Liverpool trials of commercial vehicles for the Liverpool Automobile Club and Self-Propelled Traffic Association. These were held on the worst roads which could be found in the neighbourhood and had the valuable result of disclosing points of weakness in most of the vehicles entered. Hele-Shaw took an active part in the development of motor transport at that time, which immediately followed the passing of the 1896 Motor-car Act. He was a foundation member of the Royal Automobile Club and a Member of Council of the Institution of Automobile Engineers, being elected President in 1909. He acted as a judge at almost all motor trials during that period. It is probable that it was his experience of, and interest in, transmission problems in commercial vehicles which led to the development of his hydraulic-transmission gear, although this has been applied mainly in other spheres.

Hele-Shaw resigned his professorship at Liverpool in 1904 and was appointed first Professor of Civil, Mechanical and Electrical Engineering in the Transvaal Technical Institute. He retained this post only for a year, after which he was appointed Principal of the Institute. Soon afterwards, the Secretary of State for the Colonies appointed him Organiser of Technical Education in the Transvaal. Although he remained in South Africa only a little more than two years, Hele-Shaw did good work, particularly in this latter sphere. We have suggested that he will be remembered rather as an inventor than a teacher, but as an organiser of technical education he did valuable and original work. While at Liverpool, he was chairman of the Management Committee of the Liverpool School of Technology, and then, and later, was an examiner for the old Science and Art Department of the Board of Education, for the City and Guilds of London Institute, for the Royal Naval College, Greenwich, for the University of Birmingham, and for the Civil Service Commission. His work in connection with the introduction of National Certificates is well known. In 1920, the Board of Education approached the Institution of Mechanical Engineers with the suggestion that it should collaborate in a certificate scheme to take the place of the old Science and Art Certificates. Hele-Shaw was at that time chairman of the Education Committee of the Council, and it was largely due to his influence that the scheme was put through. He became the first chairman of the Joint Committee, and retained that position until 1937. When the scheme started there were 1,253 students in 49 technical colleges working for certificates. When he retired from the chairmanship there were 3,327 students in 139 technical colleges. On his retirement, Hele-Shaw presented a sum of 200*l.* to provide an annual prize to be awarded to the best student of the year.

After his return from South Africa in 1906, Hele-Shaw set up in consulting practice in Westminster. He had carried on activities of this kind in his professional days and, for instance, was retained, in conjunction with Professor Unwin, to report on the Vyrnwy Dam. His connection, however, was mainly in the mechanical field. Although he still carried on work of this kind in Westminster, his main activities were, and increasingly became, devoted to the development of his own inventions. Probably the most important invention during the earlier years at Westminster was the hydraulic variable-speed gear, which is still the mainstay of an important business. When he delivered the Hawksley Lecture in 1921, he devoted it to the subject of such gears. He took as his title "Power Transmission by Oil," and said that, as gears of the "hydraulic" class practically always operated by oil, they should be known as "elaulic" gears. In proposing a vote of thanks, the late Captain Sankey frivolously suggested that "hele-shawlic" would be an even better term.

It is not possible to give here a complete list of Hele-Shaw's important inventions. As examples of some which became important commercial successes, however, mention may, be made of his Victaulic pipe joint and his streamline filter. This latter was a direct breakaway from previous filter practice and possessed remarkable properties which have proved of great practical value. His more recent important work, carried out in conjunction with Mr. T. E. Beacham, was on variable-pitch airscrews. He delivered a paper on this subject before the Royal Aeronautical Society in 1928.

Hele-Shaw was for long an active member of the Institution of Mechanical Engineers. He joined as a member in 1879, and was President in 1922. His first paper was read before the Institution in 1891, and his name appears at intervals in the list of papers read from that time onwards. With the Institution of Civil Engineers he was less actively connected, although he joined as student in 1878, became an associate member in 1880, and a member in 1887. As already mentioned, the first paper he ever read, in 1880, was presented to this Institution, and he similarly contributed to the *Proceedings* in 1882 and 1885. For the latter paper, on "Mechanical Integrators," he was awarded the Watt Gold Medal and Telford Premium. In all, he presented no less than 94 addresses, papers and reports to scientific societies and other bodies. Among the number were four Cantor Lectures and six Royal Institution Christmas Lectures, and several presented to the British Association; he was President of Section G in 1915. He delivered the James Watt Anniversary Lecture at Greenock in 1902, taking as his subject "James Watt, Inventor." In addition to the institutions previously mentioned, he was president of the Association of Engineers-in-Charge in 1912 and of the Society of Model and Experimental Engineers in 1914. He was an LL.D. of St. Andrew's University, a D.Sc. of Bristol, and a D.Eng. of Liverpool.

Hele-Shaw was full of life and vitality, seeming to enjoy thoroughly all that he did. Until quite recently, he regularly attended his office in Westminster, going down to his country house at West Wittering for the weekends. He retained this vitality to advanced years, and we remember him, when over 80, standing on his chair, when replying to a toast at a dinner of the Liverpool University London Society, to demonstrate some point in connection with mechanical flight with his menu card.

MR. C. S. RICHARDS.

We also regret to record the death of Mr. C. S. Richards, which occurred as the result of a bathing accident at Rio de Janeiro, on Tuesday, January 28, at the age of fifty-six. Mr. Richards was a leading member of that growing class of workers in the electrical industry who have added commercial experience to technical training and had, in particular, paid close attention to export matters. At the time of his death he was a member of the Willingdon Mission to South America.

Charles Sydney Richards was born in Manchester on February 5, 1884, and was educated at the St. Margaret's Middle School, Whalley Range, and at the Central Municipal School in that city. At the age of fifteen he began his engineering training by taking a course at the Municipal School of Technology, Manchester, and two years later entered the service of Messrs. Simpson and Bibby, traction engineers. This training was continued under the British Westinghouse Company. In 1905, he resumed his studies at the Municipal School of Technology and obtained the degree of Bachelor of Science with Honours at the University of Manchester in 1906. After a further year's practical training with the British Westinghouse Company he was appointed engineer in the turbine department of that concern and was engaged in the design of steam turbines and condensers with outputs up to the then large capacities of 5,000 kW. He also made an independent study of exhaust and mixed-pressure turbines and the utilisation of exhaust steam, and was appointed by the company to lecture on these subjects. His work on the commercial side included the preparation of complete schemes and tenders for power plants.

This work was interrupted by the war of 1914-18, during which Richards served in the Army with the rank of captain. Subsequently, his work lay with the export side of the business of the Metropolitan-Vickers Electrical Company and over a period of many years he visited almost every country in the world. One of his main activities was directed towards the establishment of the company's business with Russia. In 1922, Richards became managing director of the Metropolitan-Vickers Export Company and eleven years later joined the board of the parent concern.

MR. H. G. DRURY, M.V.O.

It is with regret that we announce the death, at Northwood, Middlesex, on January 28, of Mr. Henry George Drury, who, we believe, was the doyen of railway officials in this country. Mr. Drury, who was born on September 16, 1839, and was, therefore, in his 102nd year, entered the service of the old Eastern Counties Railway in 1854, at the age of 15, eight years before the name of this undertaking was changed to that of Great Eastern Railway. A man of ability and great energy, he was eventually promoted to the position of Assistant Superintendent of the Line, and, after occupying this office for some years, was made Superintendent of the Line, Liverpool Street, in 1897. He continued in this capacity for seven years, retiring under the age limit on December 31, 1904, his successor being Mr. R. P. Ellis. During his long connection with the Traffic Department of the Railway, many developments occurred. For example, Mr. Drury saw the early suburban traffic, running to and from Liverpool Street, increase gradually, with the introduction of workmen's tickets and other travelling facilities, into large proportions.

Mr. Drury was largely responsible for the foundation of the Great Eastern Railway Building Society and the Great Eastern Superannuation Scheme. He was for many years an officer in the Engineer and Railway Volunteer Staff Corps, and, at the time of his retirement, had risen to the rank of major. In recognition of his services in connection with the running of Royal trains, H.M. King Edward VII made Mr. Drury a Member (4th Class) of the Royal Victorian Order just prior to his retirement in 1904. For a number of years, Mr. Drury was chairman of the British Railway Traffic and Electric Company, Limited, and a director of the Southend Waterworks Company. He was chairman of the Retired Railway Officers' Society from 1911 to 1913.

THE APPRENTICE.

By Cyril J. Atkins, A.M.I.Mech.E.

The importance of the apprentice in the social and industrial life of the community was fully recognised in early mediæval times when the master, under the craft guild, received his apprentice into his home as a member of his family, and was responsible not only for his craft training, but also for his good behaviour. It was considered that the system gave good opportunities for discipline, which was salutary for both the formation of character and trade skill. In view of this, many privileges were extended to the young journeyman on completion of his training, such as the right to become a freeman of the city. The craft guild apprenticeship system flourished for two or three hundred years, until the exclusiveness of the guilds fostered the growth of the domestic system of industry in the Fifteenth to Seventeenth Centuries. In this, a regular apprenticeship was difficult, and training was limited to the handing on of skill from father to son.

During the latter half of the Eighteenth Century, machinery began to replace manual labour and heralded the dawn of the factory system which, in its unbridled early activity, brought much misery and suffering, recognised, but ignored, by many

of the mill owners. Ultimately, however, the policy of *laissez faire* was overcome, and legislation was introduced for the protection of women and children in industry. Among this, in 1802, Sir Robert Peel, a mill owner and father of the great statesman, brought in a bill for the regulation of apprentices in the cotton trade; this dealt with the clothing, meals and dormitories for the factory apprentice, as well as insisting on adequate provision for instruction. The measure shows a further acknowledgment of the fact that an apprenticeship is not only a period for the learning of a trade, but also a time for training in regular habits of life.

The factory system brought a renewed recognition of the importance of the apprentice. In the last thirty or forty years of the Nineteenth Century, the apprentice was a valued member of industry, his prospect being secure by virtue of the legal articles of his apprenticeship and the assurance that the skill acquired would ultimately provide a comfortable status in society. The growth of the Mechanics' Institutes in various towns gives evidence of the enthusiasm and prominent position of the apprentice and young journeyman of this time. The increasing industrial importance of Great Britain at this period was largely built on the skill and integrity of character of the craftsman.

At the commencement of the present century, however, British industrial supremacy suffered a sharp shock; the scientific investigations of such as F. W. Taylor, Gilbreth, Fayol, and others, in America and on the Continent, pointed to a new era in the factory system. From the upheaval of the Great War, and the subsequent period of trade depression, there arose a realisation that modern production called for intensive organisation and division of labour, with an attendant increase in the proportion of unskilled to skilled labour, and the replacing of many skilled processes by the work of special-purpose machines. The vital fact that the skilled craftsman was still essential, even though he formed only a small nucleus, was obscured in the insistent demand for more and cheaper production. Apprenticeship schemes were abandoned and forgotten. In spite of many warnings from keen observers, and in striking contrast to the growing practice of neighbouring countries, the elimination of opportunities for apprenticeship continued among both the smaller firms and the larger combines. A few maintained their schemes, providing by trade, engineer and student apprenticeships, a remnant of skilled craftsmen, designers and executives.

The accumulating evils of unemployment, "blind alley jobs," and the alarming scarcity of skilled men led the Ministry of Labour to develop training centres which, at this moment, are a prominent feature of the war effort. In pre-war days, intensive training was given to lads at the minimum age of 18 years. The scheme has many virtues, and acknowledges the need for the dual training in both craft and citizenship by providing trade and educational instructors. It fails in a measure, however, by deferring the training. Many of the trainees, having left school at 14 years of age, have been largely withheld from the discipline of industry during the gap of four years, and in many cases have lost some of the desire for regular habits of life. A new Britain is the present aim, and one of the avenues suggested is an extension of the school age to 16 years. Could not this be coupled with a new national apprenticeship—a "sandwich" system in which the Ministry of Labour and commercial firms co-operate, holding the lad immediately on his leaving school?

In the face of remorseless competition, private firms find it difficult to devote time and money to the training of apprentices. In his first year, an apprentice demands much time and attention from a highly-skilled man and, in return, he yields little or no actual production. After this initial stage, the lad gains a workshop atmosphere and is a useful helper to a skilled man in two-handed jobs. With increasing years, his usefulness leads to actual production while learning. These varying stages should be recognised in planning a scheme of apprenticeship, and the following suggested example of a co-operative apprenticeship indicates how this might be accomplished, in accordance with the accompanying time-table.

During the first year, the lad receives a training similar to that of his predecessor, the craft guild apprentice, and acquires "factory sense" without the strain of the incessant demand for more and more production. In his second year, as a very useful helper, valuable to a commercial enterprise, he gains experience of production machinery and plant requirements. In his third year, his increasing skill wins for him a useful sphere in the tool-room. To broaden his outlook, he should know something of the fundamentals of the companion crafts, but the firm will not wish to sacrifice a useful man by making him a beginner and, of course, many firms

Age.	Location.	Training.
16 –16½	Government Training Centre	Fitting and bench work.
16½–17	" " "	Machine shop.
17 –17½	Co-operating Firm	Millwright or maintenance.
17½–18½	" "	Tool setting.
18½–19	" "	Tool shop.
19 –19½	Government Training Centre	Forge, foundry, patternshop.
19½–20½	Either Location	Drawing office.
20½–21	Co-operating Firm	Allocated according to progress.

have no forge or foundry. Hence, at this stage, the trainee should return to his first "home," the training centre, to begin again for a few months. When he emerges, with a good measure of skill and knowledge, his firm could usefully employ him in the drawing office, or alternatively, this instruction could be provided at the training centre. Within six months of the completion of his time, the youth has probably discovered latent abilities and inclinations, and from his records of progress a supervisor should allocate him a position in industry, as a skilled journeyman, inspired and directed by ambition and self-respect during his five years since leaving school. Throughout the period, the lad should be given facilities for technical training, following some progressive course such as that for the National Certificate. By nurturing the lad in his early years and guiding him progressively in industry, valuable ambitions should be engendered in his mind, with happy associations, and the nation would gradually build up a reserve of craft-power for the arduous work ahead.

LETTERS TO THE EDITOR.

CONCRETE FOR BUILDING.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to Mr. Lindsay Forster's letter which you published in your issue of January 17, page 54, on the use of broken brick as a concrete aggregate, I think it as well to point out that, although concrete of good strength can be obtained with the use of brick aggregate, it is essential that the broken brick should be thoroughly cleaned, to remove adhering plaster, etc. Failure to do this may prove serious on account of expansion effects. Bricks which show signs of efflorescence should not be used for the same reasons.

Concrete made with broken brick is more fire resisting than concrete made with a shingle aggregate, but owing to the porosity of building bricks, there may be a danger of corrosion of steel if this type of aggregate is used in reinforced-concrete construction. The broken brick should, of course, be soaked with water before use.

Yours faithfully,
R. H. HARRY STANGER.

Testing Works and Chemical Laboratories,
Broadway House,
24, 26 and 28, Tothill-street,
Westminster, London, S.W.1.
January 31, 1941.

235-B.H.P. GAS ENGINE AND CRANKLESS GAS BOOSTER.

TO THE EDITOR OF ENGINEERING.

SIR,—Considering the outstanding contributions of the Michell brothers to mathematical research and scientific discoveries as applied to engineering throughout the world, it is more than regrettable that such a serious mistake should appear in print as the reference to "the late Mr. A. G. M. Michell" in your description of the above combination, in your issue of January 24.

Mr. A. G. M. Michell is, fortunately, still in the land of the living, and will be interested, and doubtless gratified, that Messrs. George Waller and Company are to-day utilising his crankless principles and designs.

Yours faithfully,
W. H. GRIEVE.

Alpax Works,
St. Leonards-road,
Willesden, N.W.10.

[We regret exceedingly that this error should have escaped our notice, and hope that this correction will be effective in preventing inconvenience to Mr. Michell and his many friends in this country, Australia, the United States, and elsewhere.—ED., E.]

THE GRETNA JUNCTION RAILWAY ACCIDENT.

ON November 7, 1940, at Gretna Junction, on the main Carlisle-Glasgow line of the London Midland and Scottish Railway, a collision occurred between the northward bound 10.5 a.m. express from Euston to Perth and a southward bound freight train from Shawfield to Carlisle. As a result, the driver of the express and two passengers were killed and the fireman of the express and forty-one passengers were injured.

An inquiry into the accident was held by Colonel A. C. Trench, who has now reported to the Minister of Transport that there were no defects in the permanent way or in the rolling stock or brake equipment of either train. All the evidence also points to there having been no defect in the signalling equipment. At the place of the accident, the double-track main line of the old Glasgow and South Western Railway to Dumfries leaves the main line of the original Caledonian Railway to Carstairs and the north, and the report explains the signalling arrangements at this point in considerable detail. An important feature is that the outer distant signal for trains approaching Gretna Junction from Dumfries is an electrically-operated repeater of the inner distant. Owing to the presence of an overbridge, the latter has co-acting arms on one post, so that when the junction distant is off the signal post presents the unusual aspect of four green lights one above the other.

The evidence, which was very conflicting throughout, shows that the signals were off and the road was set for the express on the main line. The speed of the express was about 45 m.p.h., and was not checked at all. Actually, both the up and down road points were set for the main-line and, if the goods engine had run a few yards farther, it would have burst through the trailing points. It is therefore clear, in Colonel Trench's opinion, that the goods train must have passed one or more signals. The driver of the goods train stated that as he approached he saw the outer and inner distants for Gretna Junction in the caution position, but that the inner distant was pulled off before he reached it. The outer home was also off, but the inner home was against him. He immediately made a full application of the brake and almost managed to stop before reaching the junction. The evidence of the fireman and guard was also to the effect that the inner distant was at clear, a circumstance which, coupled with its very unusual appearance of four green lights one above the other, made it necessary to investigate the chance of this taking place. The only possibility appeared to be that the signalman in the Gretna Junction box had originally intended to pass the goods train, had set the junction for it and had pulled off the signals as soon as its approach had been intimated to him by the annunciator in rear of his up outer distant. Immediately, thereafter he might have realised that the express was approaching and have decided to pass this ahead of the goods. This would have entailed placing the up branch signals to danger and lowering the down main signals for the express. A test showed that these operations would have taken about 17 seconds, so there was an interval of 30 seconds or more between the time when the driver of the goods train saw the up outer home in the off position and the enginemen of the express saw their down distant off. The signalman, however, maintained strongly that he had not altered the road and that he had never had any intention of allowing the goods to pass before the express.

In commenting on this evidence, Colonel Trench points out that if the signalman is to be believed it follows that the driver of the goods train passed the outer distant, the inner distant and the outer home signals, either without attempting to stop or deferring his attempt until too late. In this case, the evidence

of the driver and its confirmation by his fireman and guard regarding the aspects of the outer and inner homes must be false. This, Colonel Trench considers, is unlikely. If, on the other hand, the driver's statement is accepted, the signalman must have changed the road in face of the approaching goods train, which, in view of his experience, seems unlikely. It is, however, significant that the signalman got "Train Entering Section" for the goods train some five minutes before he heard anything about the express, and that a down passenger train for Dumfries, which would not have interfered in any way with the running of the goods train, was normally due about this time. It has, unfortunately, been impossible to ascertain the time at which the signalman was informed that the express was for the Caledonian and not for the Glasgow and South Western line. Assuming that he had set the road for the Glasgow and South Western line before he had heard of the approach of the express, he might have pulled the signals off for the goods and only subsequently realised that he should have given precedence to the express. He might then have started to change the road, not realising how near the goods train was, and have finished the operation in time for the driver of the express to see his distant in the off position. Against this theory is the signalman's entry offering the express forward to Quintinshill immediately he got the "Train Approaching" signal from Mossband in the rear. After this he could hardly have contemplated pulling the signals off for the goods train to allow the crossing movement to take place. The Quintinshill booking for this signal is, however, two minutes later than that entered by the Gretna Junction signalman, *i.e.*, after the latter might have pulled off for the goods train.

Summing up, Colonel Trench regrets that he cannot do more than offer an opinion based on the apparent possibilities. He considers it more likely that the signalman, anxious not to delay the express, may have changed the road in face of the goods train, not realising that it was too close to be able to stop clear of the junction. The alternative explanation, which he considers less probable, is that the driver of the goods train, expecting the signals to be pulled off as he approached, took no steps to control his train until he was too close to be able to stop at the outer home and actually overran this signal by some 600 yards, after which he arranged immediately with his fireman and his guard that they should support his unusual story of the inner distant having been pulled off in his face. His experience of being stopped at this junction on previous occasions is another reason for making this seem unlikely.

In conclusion, Colonel Trench remarks that there are no grounds for criticising the authorised practice of accepting trains to the up branch outer distant when the junction is blocked, in spite of the falling gradient immediately approaching the junction. The outer and inner distants give ample warning and the gradient does not commence to fall until the inner distant, while the outer home is beyond the prescribed distance. The arrangements for notifying the signalman at Gretna Junction of the route of a train approaching from the south might be improved, especially under the present conditions of frequent specials and "out of course" running. The existing regulations prescribe a special two-bell signal for trains to the Glasgow and South Western line, which is sent from Floriston when the passing engine driver signals his route by a whistle. There is no such signal for a train to the Caledonian line, which is undesirable, especially now that the disparity between the traffic on the two lines is less than in normal times. In this case, the signalman did not, of course, receive this bell signal, but he was informed by telephone from the Kingmoor box at Carlisle that the Glasgow and South Western train was following the north express. This appears to be a common, but not invariable, procedure. It is true that the existence of splitting distants for Gretna Junction permits a driver to come to a stand before the junction if he finds he is wrongly routed, but the possibility of crossing movements such as arose in this case make it important for the signalman to become aware of the routing of a down train in good time. Colonel Trench, therefore, suggests that the railway company should consider methods of improving the transmission of such advance information by a positive signal from Carlisle or elsewhere for all trains.

CHADWICK PRIZE ESSAYS.—The Chadwick Trustees recently offered two prizes, of 100*l.* and 50*l.*, respectively, for essays on the construction and management of air-raid shelters, with special reference to ventilation, sanitation, and the provision of sleeping accommodation. The Trustees have recently awarded the first prize of 100*l.* for the essay submitted jointly by Mr. P. O. Reece, A.M.Inst.C.E., and Dr. S. L. Wright, M.R.C.P., D.P.H., of Wembley, Middlesex; and the second prize of 50*l.* to Mr. J. F. Adburgham, L.R.I.B.A., of Victoria-street, Westminster, London, S.W.1.

LABOUR NOTES.

On Wednesday last week, the Production Executive of the Cabinet had a conference with the Committee of the British Employers' Confederation and the General Council of the Trades Union Congress on the subject of man-power and woman-power in industry. Mr. Bevin, the Minister of Labour and National Service, presided, and the other Ministers present included Lord Beaverbrook (Aircraft Production), Mr. Alexander (Admiralty), Mr. Lyttelton (Board of Trade), and Sir Andrew Duncan (Supply). The basis of discussion was a memorandum the main features of which were subjects dealt with by Mr. Bevin in the speech delivered by him in the House of Commons in the previous week. Points from that speech were explained in these notes a week ago. The Minister of Labour and National Service intends to draw up an industrial register, and before proceeding to prepare it, took this opportunity to consult the representatives of the employers and also those of the trade unions.

The Minister of Labour and National Service stated later that in the preparation of the Order and the framing of the rules for its application his Department would keep in touch with the Consultative Committee. The scheme would have to be worked out with considerable care, and he had the fullest assurances that so far as voluntary effort could secure the requisite numbers and the efficient use of the labour force, he would have the whole-hearted co-operation of the employers and the trade-union leaders. He had made an appeal to industries to examine carefully the problem that had to be faced. Any scheme that an industry might bring forward quickly would have the most careful consideration of the Ministry with a view to its adoption. The conference was anxious, he said, that nothing should disturb the joint machinery that functioned in industry, and was also insistent that whatever sacrifices were required should be borne equally. There was a conviction that, while direction might have to be used in certain circumstances, if the maximum output were to be achieved, the willingness of the people must be encouraged. He would make the most he could of voluntary effort, but he wanted an immediate response to fill vacancies which were occurring now.

Continuing, Mr. Bevin said that he had asked the employers' organisations and the unions to examine this problem very much as they did the problem of man-power for the armed Forces. The movement of people from their employment—in many cases, secure employment—to help the State, should be done in an orderly way, and employers should be encouraged to give facilities and assurances of employment, and where there was heavy loss, to assist in the way they did when men went into the Army—that was in advance of the registration scheme. The Minister said that he could not wait until the whole registration scheme was worked out. In certain trades he would do as he had done in the case of the engineering industry some months ago, and carry out an industrial registration in order to ascertain the people who had left the industry and whether, in the industry in which they were now employed, they were doing "essential work." One of the most urgent matters was, he added, to increase the labour force in the shipbuilding industry.

The general registration of women will probably take precedence of the general registration of men. The number of unemployed men is, in fact, small, and the problem in their case is redistribution and replacement by women, so that industry as a whole may yield to the armed Forces the men they require while maintaining all essential production. It is possible that the information already in the possession of the Ministry may render unnecessary a second registration for men. One thing on which, it is believed, assurance can be placed is that the military limit will not be raised until there has been thorough inquiry into the use, in industry, of men at present of military age.

In the case of women, the reserve labour force is much larger, and an Order for the compulsory registration of women may be expected shortly. It will provide for calling up for registration by age groups, beginning probably at the age of 20 and going upward as industrial requirements make necessary. There will be provision for appeal. As far as possible, the Ministry will place women in work near their homes. If they have to go a distance, they will be paid 10*s.* travelling expenses if the journey takes a day, or 5*s.* if it takes half a day; and on arriving at the job they will receive a week's lodging allowance of 24*s.* 6*d.* as "settling in" money.

The memorandum and statement submitted to the conference was considered by the General Council of the Trades Union Congress at a meeting on Thursday and it was agreed to give full co-operation in the carrying out of the mobilisation of labour and industrial registration on the lines laid down.

In a memorandum explaining the new calling-up Proclamation, the Minister of Labour and National Service says:—"Registration of further age classes will be accompanied by an amendment of the existing Schedule of Reserved Occupations. These amendments, besides raising the existing ages of reservation in a number of cases, will make reservation depend to an increasing extent upon the actual work being done by the men for whom reservation is being sought and not simply upon his age and registered occupation. The preparation of the necessary amendments to the schedule on this revised basis has reached an advanced stage and as soon as the work is completed details will be announced." According to the memorandum, "it is an authoritative opinion that 'before we are through the war the position will require that no man shall be allowed to do work if there is a woman to do it.'"

An Order in Council issued by the Governor-General of New Zealand in virtue of the Emergency Regulations Act of 1939 provides for the introduction of national service for all persons irrespective of sex, who are over 16 years of age and are resident in New Zealand, and governs the conditions under which such persons or certain classes of them may be called up for work of essential national importance or for service with the Armed Forces. Under the provisions relating to national service outside the Armed Forces, every person, irrespective of sex, who has attained the age of 16 years and is resident in New Zealand is considered to belong to the General Reserve of the nation. The Minister of National Service may divide this reserve into classes which may be enrolled at the order of the Governor-General according to requirements. As soon as the enrolment of a class of reservists has been ordered, the Director of National Service must prepare a register of all persons belonging to that class who, for that purpose must inform him of their name, address, date of birth, occupation and any other particulars that may be required by the Minister. This register must be kept up to date. In addition to the national register, district registers may be kept for such local sub-divisions as may be decided on by the Minister.

When it appears to the Minister of National Service to be necessary or expedient so to do in the interest of public safety, the defence of the country or the efficient prosecution of the war, or for maintaining supplies and services essential to the life of the community, he may direct any male or female reservist to perform such services in New Zealand as may be specified, except military service, provided that he or she is capable, in the opinion of the Minister, of performing them. Any services carried out in virtue of directions given in the manner indicated must be subject to the same terms, as to remuneration and conditions of service, as are applicable to work of the same kind under laws, regulations, arbitration awards or industrial agreements. In the absence of such provisions, the conditions are prescribed by the Minister of Labour.

For the reasons of public interest which have been mentioned, the Minister of National Service may also direct that any persons or class of persons who are employed in any specified industry or undertaking shall not relinquish employment in that industry without first obtaining his consent. Persons subject to such control and also persons performing services for which they have been called up, must at once notify the Director of National Service if they cease to be engaged in an essential occupation or if they change their employer or cease to be employed. Similarly, the employer of any person belonging to these classes must immediately notify the Director of National Service if the person so engaged leaves his employment or otherwise ceases to be engaged in an essential occupation.

The *Review* of the International Labour Organisations—which is now based on Montreal—states that the National Defence programme of the United States is accompanied by measures to adapt the employment market to emergency defence needs. The Social Security Board and the National Defence Advisory Commission accepted a series of recommendations made by the Board's Federal Advisory Council, which establish general policies for the organisation of the employment market and of training programmes. Inventories have been taken to determine the vocational qualifications and location of the labour supply available for defence industries; a national system of labour clearance has been introduced; training and re-training programmes have been expanded and co-ordinated with the defence programme; and new administrative machinery has been developed.

THE ENGINING OF HIGHLY POWERED SHIPS.*

By SIR STEPHEN J. PIGOTT, D.Sc.

(*Concluded from page* 80.)

WHEN the Cunard Company envisaged the building of two vessels to maintain a weekly express service between Southampton and New York, the directors and Mr. John Austin, the superintending engineer, were faced with the problem of choosing between the proved reliability of the propelling machinery of the Aquitania and the advantages which could be expected with the more modern water-tube boilers and geared turbines. So vital is the regularity of sailing in such services that the relative values were assessed in proportion of 80 per cent. on reliability and 20 per cent. on fuel economy. Acting upon the request of their superintending engineer, the Cunard Company again invited a committee of experts to consider this problem of propulsion. The following abstract from the 9th Thomas Lowe Gray Lecture, given by Mr. John Austin in 1937, before the Institution of Mechanical Engineers, serves to confirm the importance attached by the Cunard Company to this problem of propulsion :—

"As the type of machinery to be adopted was of supreme importance, the Board of Directors of the Cunard Steam Ship Company, Limited, under the chairmanship of Sir Thomas Royden, Bart., in January, 1928, invited a number of leading engineers to act in an honorary capacity on a committee for the purpose of recommending the type of propelling machinery which should be adopted in the new vessel. Consideration was given by the committee to the following types :—(1) the single-reduction geared turbine with Scotch boilers ; (2) the single-reduction geared turbine with high-pressure water-tube boilers ; (3) the turbo-electric drive with Scotch boilers ; (4) the turbo-electric drive with high-pressure water-tube boilers ; (5) the Diesel-electric drive.

"After thoroughly investigating the merits of each of these types the committee unanimously recommended the adoption of single-reduction geared turbines as the most suitable for the vessel on the grounds of reliability, simplicity in operation, lightness in weight, efficiency, freedom from noise and vibration, cheapness in first cost, and low cost of upkeep. The committee also recommended the use of high-pressure water-tube boilers with superheaters and air-preheaters.

"The Cunard Board of Directors, under the chairmanship of Sir Percy Elly Bates, Bart., in 1930, adopted the recommendations of the Engineering Advisory Committee, and in due course tenders were invited for the construction of the first of the two ships. The specifications called for the single-reduction geared turbines to be of the Parsons type and the water-tube boilers to be of the five-drum Yarrow type, also for the auxiliary machinery—with a few exceptions—to be driven by electrical power."

All features of the Queen Mary (Fig. 8, on this page) have been so fully dealt with by the Press that any further statement must be largely repetition. During a cruise of this ship before entering service in 1936, a member of His Majesty's Government asked whether the experience gained in propelling merchant ships was of service in designing the machinery for naval vessels, and, conversely, whether experience gained in naval vessels had aided in designing the propelling machinery of the Queen Mary. The answer was that the experience gained in the building of the machinery of H.M.S. Hood, and the particulars of her service made available by the Admiralty, had been fully utilised by the builders of the Queen Mary, and that the experience gained in service with this large merchant ship must influence subsequent design for naval vessels.

The natural water supply available at ports of call is always a matter of concern, and the method employed in rendering the shore supply suitable for the boilers of the Queen Mary is of interest. With the introduction of large boiler installations on board ship, consisting of numerous units of the high-pressure water-tube boiler type and with superheaters, the purity of feed is of major importance, and justifies considerable expenditure in purification plant. Over a period of years, the Cunard Line have had experience of softening plant in certain of their larger vessels, including the Aquitania, and when considering the feed system for the Queen Mary, Mr. Austin decided on water-softening plant of the lime-soda type, to deal with all the feed water for the complete boiler installation. This plant is capable of treating 300 tons of feed water per 24 hours, and consists of two independent units, the first being the lime-treatment unit and the second the soda or base-exchange portion. With water of considerable hardness, both parts are in operation ; so that, after reducing the initial hardness to a reasonable figure, the partially softened water is passed through the base-exchange portion, and the final water passes to the feed system in a purified state, containing the minimum of salts and being of slight alkalinity. When hydrant water having a moderate hardness is available, the first portion of the plant is not put into operation. In addition to the softening plant, the Queen Mary has evaporators which can provide all the make-up feed required for the main engines. These methods proved their great value, and examination of the boiler tubes after lengthy periods of service has fully justified the precautions taken.

The Queen Mary is the first highly-powered vessel to have four turbines to each main gear wheel, and employing "quill" shafting for this power transmission. As the extensive use of this "quill" drive is somewhat unique, it may be of interest to explain it. In the investigation of the torsional oscillating system of the Queen Mary and Queen Elizabeth it was found that the lowest critical speed approximated very closely to the running speed of the main shafts. In previous work of this character, the question of synchronism of the revolutions with the critical frequency had not been considered, as a rule, but always the multiple of the revolutions by the number of blades of the propeller. In smaller vessels, the critical frequency of the oscillating system usually comes out well above the actual speed of revolution, and well below this multiple with engines amidships. However, the large passenger liner had created an entirely new problem. Lack of experience with a condition such as this made it somewhat difficult to assess what importance should be attached to this point. The calculations were attacked, however, with the knowledge of two possible sources of synchronism with the propeller revolutions ; namely, errors in the gear-wheel teeth, and lack of uniformity in or damage to one of the propeller blades. Trouble due to gearing errors was quickly dealt with by considering the mode of vibration at this troublesome critical speed. The node point is situated very near to the gearing, and therefore any small variation in angular velocity of the gear wheel would correspond to a very much larger variation in the angular velocity of the propeller, and any such motion would be strongly and effectively damped by the dash-pot action between the water and the propeller. The condition of a damaged propeller blade setting up a vibration per revolution was more disconcerting, and would undoubtedly cause synchronous vibrations in the shafting. The gravity of such a condition was not easily appraisable, and therefore the shafting was so designed that the lowest critical speed was appreciably above the working full-power revolutions.

In installations such as those in the Cunard express liners, smoothness of drive must be a prime consideration, keeping in mind the danger of resonance with any of the critical speeds. Calculations of the natural frequencies of the undernoted systems were made and

* Sir Charles Parsons Memorial Lectures, delivered at the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne, on December 17, 1940. Abridged.

MACHINERY FOR HIGH-POWERED SHIPS.

Fig. 8.

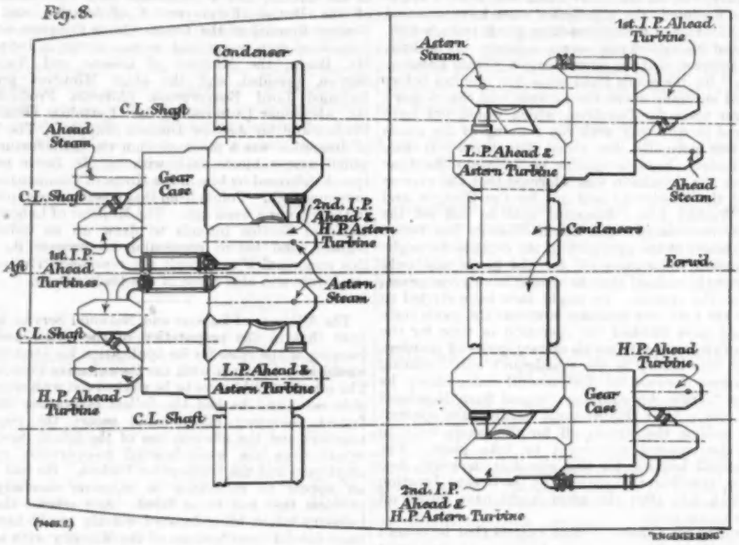
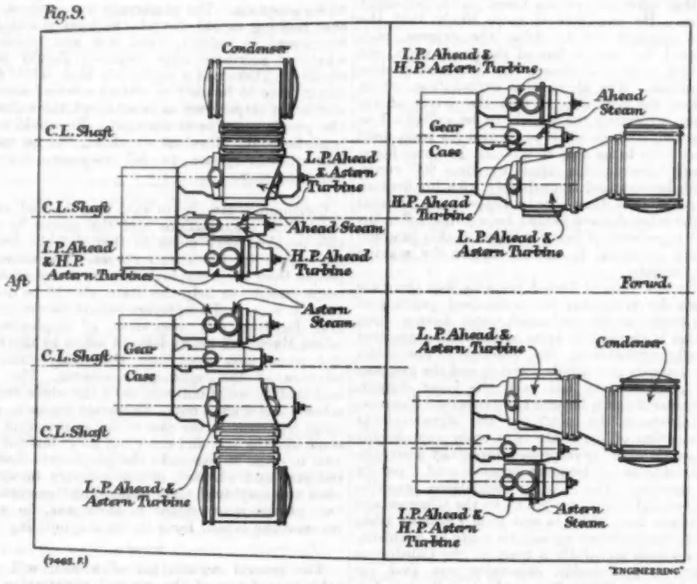


Fig. 9.



MACHINERY FOR HIGH-POWERED SHIPS.

Fig. 10.

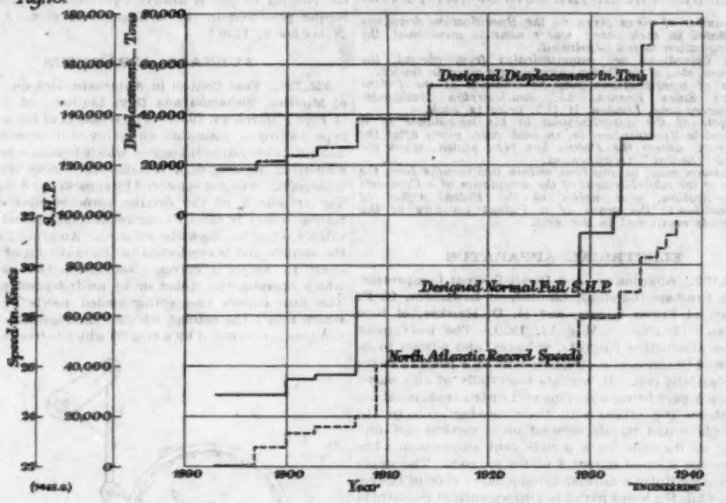
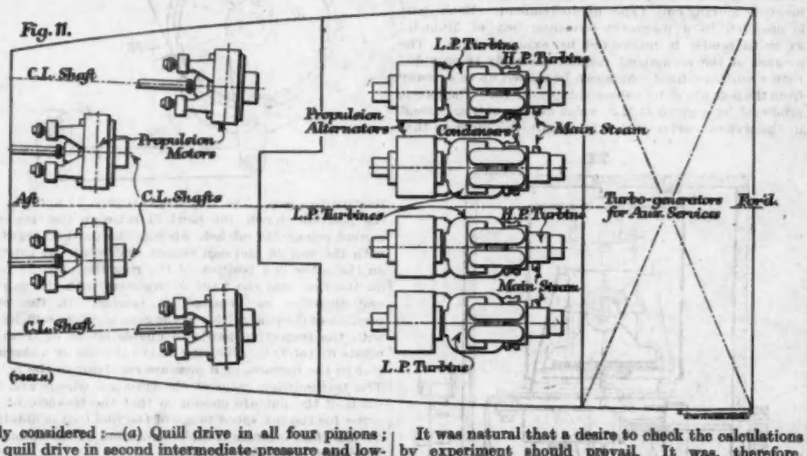


Fig. 11.



duly considered :—(*a*) Quill drive in all four pinions ; (*b*) quill drive in second intermediate-pressure and low-pressure pinions, and solid drive in high-pressure and first intermediate-pressure pinions ; (*c*) solid drive in all four pinions. The quill drive on all four pinions was considered the most satisfactory, the natural frequencies being estimated as follows :—Inner shafts : 205, 356, 606, 895 and 1,169 vibrations per minute ; outer shafts : 202, 356, 604, 818, 895 and 1,184 vibrations per minute.

The additional natural frequency in the outer-shaft system obtains through the turning-gear wheel being placed at the end of a short length of shaft forward of the main gear wheel. The corresponding critical revolutions of the inner and outer units can be obtained by dividing the natural frequencies by four, because of the periodic variations in torsional load on the four blades of the propeller as it cuts through the stream lines of varying velocity. The critical revolutions may be tabulated as follows :—Inner shafts : 51, 89, 151, 224 and 292 r.p.m. ; outer shafts : 51, 89, 151, 204, 224 and 296 r.p.m. As the revolutions at normal service would be about 175 r.p.m., the machinery operates at a speed well removed from any of the above critical speeds.

It may be considered that the calculations, and hence the vibration system, could have been simplified considerably if all the rotating masses had been "tuned" to a specific frequency about the gear wheel, thus giving one particular frequency of vibration of the system as against the number shown. "Tuning" of the vibrating system was given great consideration, but was considered impracticable ; additional flexibility was given to the system, however, the turbines and pinions being connected by a comparatively small shaft of dimension sufficient for the transmission of power. This shaft, which passed through the centre of the pinion, was coupled to it at the end remote from the turbine with a flanged coupling, with the usual type of claw flexible coupling between the turbine rotor and this small quill shaft.

It was natural that a desire to check the calculations by experiment should prevail. It was, therefore, decided to fit the Geiger torsiograph. The belt drive for the torsiograph was taken from two positions on the main line shafting, each midway between two of the nodes of the vibrating system. Torsiograms were taken at both positions from zero to full-power revolutions, and it was pleasing to find, on analysis of the records, almost complete absence of shafting oscillation at all speeds of revolution. A great measure of the success obtained, from a torsional-oscillation standpoint, can be attributed to the dynamic balancing of all rotating parts, and the static balancing of such components as were precluded from dynamic balancing by mass and dimensions.

On trial and on special voyages the propelling machinery has developed power greatly in excess of that designed for normal service, and most of the minor troubles experienced might not have occurred had the speed of the ship been limited to that of normal service. These minor machinery troubles were confined to the high-pressure turbine and the following corrections are of interest, and instructive :—(*a*) To counteract the troubles which arose from cracking of nozzle vanes, the first-stage high-pressure ahead nozzle plates, originally made of cast steel frames with Staybrite vanes cast in, were replaced by built-up nozzle plates having mild-steel frames and stainless-steel vanes, machined from the solid, secured to the frames by welding. (*b*) The nozzles were arranged in groups, with a pitch between the groups equal to one and a half times the normal pitch, so that impulses from adjacent groups might be anti-phase to each other, thus eliminating the possibility of blade vibration building up from steam-jet action. (*c*) The impulse blades of the first row in the first-stage wheel were very considerably increased in section, and were made of taper form from top of packing piece to blade tip, in order to remove the natural frequency of blade vibration from the danger zone. For a like reason, the second row of wheel blades were also increased in section. (*d*) The stationary or casing blades at this stage were increased in section and made of taper form from top of packing piece to tip of blade, to withstand the effects of vibration, and were arranged in anti-phase groups to protect the second row of rotor blades from any possible vibration due to jet action from the steam issuing from these stationary blades. (*e*) In the blading as originally provided, stiffening wires were fitted at gaps in the shrouding, and these were found to be considerably grooved by rubbing on the blades due to vibration. As a result of fitting the heavier blade sections, these wires were considered unnecessary and were dispensed with.

The outbreak of war in September, 1939, prevented the usual procedure in completion of the Queen Mary's sister vessel, the Queen Elizabeth, and we must, therefore, await the restoration of peace for direct comparison of the service of these ships. There is comparatively little difference in the machinery installations, the chief being in the battery of boilers. In the Queen Mary, 24 water-tube boilers of Yarrow type provide for the ship's propulsion, with three cylindrical boilers of lesser pressure for the "hotel" services. In the Queen Elizabeth, 12 Yarrow-type water-tube boilers supply the steam for all purposes. The turbines, gearing, shafting, propellers, etc., are the same in all respects.

Of the Bremen (Fig. 9, opposite) and Europa, the only particulars known to us are as published in the Press, and suggest nothing of outstanding interest. The performance, however, was sufficiently creditable to regain to Germany for a period the Blue Riband for the Atlantic crossing. It might be of interest at this point to refer to Fig. 10, on this page, where the development in displacement, shaft horse-power and speed of North Atlantic liners is shown graphically. The propulsive system of the Normandie (Fig. 11, annexed), being the latest and probably the most highly-powered example of electric propulsion, is of great interest, especially as being the only existing rival to the geared turbine for highly-powered vessels.

In the absence of direct experience of the construction or working of such installations, it is not feasible to attempt detailed description or to make comparison with propulsion by geared turbine. That more general adoption of this system has not resulted from earlier applications of the electric drive in this country and in America may be assumed as due to :—(*a*) The highly satisfactory application of the mechanically-geared turbine ; (*b*) the progressive improvement in the hobbing of gear wheels and pinions ; (*c*) the higher economy resulting with geared-turbine units ; (*d*) the thought that, with electric drive, conditions of specification obtain to greater extent ; (*e*) the expectation that the first cost is higher than that of the geared turbine ; (*f*) the desire of the marine-engine builder to manufacture with existing plant the main items of the propelling machinery.

The earlier tools for gear hobbing were not of high precision, and considerable pitch variation occurred in the gears produced. The "creep" mechanism developed by Parsons had for its object the mitigation of the effect of such error. In America, while a relatively high degree of precision was obtained with the hobbing of smaller gears, machines did not exist in the earlier years for producing the large reduction gears required for ship propulsion, whereas plant for the production of large turbo-generators and electric motors had reached a high stage of development for land installations. Under such conditions, it is understandable that the United States Navy should decide to try out electric transmission in the aircraft-carrier Langley, and the capital ship New Mexico, and subsequently in the very highly powered aircraft-carriers Lexington and Saratoga, doubtless with satisfactory results. That this system of power transmission has in recent years been replaced in the American ships by mechanical gearing has been attributed to the lower first cost and the lesser overall weight of geared turbines.

In the period of approximately 30 years since the earliest commercial application of mechanical reduction gearing, the art of gear hobbing has greatly advanced. Even in gears hobbed some 20 years ago, the pitch variation was of such degree as to cause rapid wear in service of the teeth of wheel and pinions, which, if not too advanced, was corrected by re-hobbing of the gear parts ; while, with gears produced by a gear hobber of to-day, the pitch variation is reduced to a negligible quantity.

Reference has not been made to propulsion by oil engines ; while the very wide adoption of the oil engine is fully recognised, it is considered that its application has not extended to ships that may to-day be termed "highly powered."

In concluding this lecture, I desire to express indebtedness to the directors of Cunard White Star, Limited, for permitting the abstract to be made from the Report of the Cunard Committee of 1904 ; and for the assistance given by members of the staff of Messrs. John Brown and Company, Limited.

ALUMINIUM CASTING ALLOYS FOR INTERNAL-COMBUSTION ENGINES.

EXCEPT in special instances, the light-alloy components of the internal-combustion engine are products of the foundry and the demand for materials to meet a variety of conditions has resulted in the development of a wide range of aluminium casting alloys. Both large and small castings are embodied in one engine, and these are produced by sand-casting, gravity die casting or pressure die casting. Various typical alloy groups and compositions which have proved satisfactory in meeting the many economic and technical requirements of the production and operation of the modern internal-combustion engine are discussed in two publications recently issued by Messrs. Aluminium Union Limited, The Adelphi, Strand, London, W.C.2. For the most massive, nominally unstressed, parts of relatively simple design a zinc-aluminium alloy, containing 13·5 per cent. of zinc and 2·75 per cent. of copper, is recommended. Not only is the alloy reasonably strong and ductile, but it possesses good free-cutting properties; its resistance to corrosion, however, is low. For relatively complex castings of comparatively light prevailing section, or having marked variations in section, alloys of the copper-aluminium series are advocated as their foundry characteristics are satisfactory, this being particularly true in alloys of higher copper contents. An alloy containing 12 per cent. of copper and an aluminium content of not less than 85·5 per cent. has been found specially useful for pump bodies, manifolds and similar parts where a dense pressure-tight casting is required. The material possesses good fluidity and it may be cast by the sand and the gravity and pressure die-casting processes.

Of particular interest among the copper-containing aluminium alloys are those intended for service at elevated temperatures. To meet the demands made on pistons, for example, an alloy containing 10 per cent. of copper, together with small additions of iron and magnesium, has been developed. This alloy, it is stated, is frequently used in place of a more expensive alloy containing 4 per cent. of copper, 2 per cent. of nickel, and 1·5 per cent. of magnesium. Not only is the former alloy cheaper, but it is easier to machine and is less liable to porosity troubles. Both alloys are employed in the heat-treated condition, and both are stated to be stable and mechanically strong at temperatures of up to 400 deg. C. They may be sand-cast or gravity die-cast. In addition to the well-known binary silicon-aluminium alloys containing 13 per cent. of silicon, mention is made of a complex alloy containing 5 per cent. of silicon, 1·2 per cent. of copper, and 0·5 per cent. of magnesium. The mechanical properties of this alloy may be varied within wide limits by suitable heat treatment. Furthermore, it is emphasised that its foundry characteristics are excellent and that it yields sound, pore-free castings in both sand and chill moulds. Its satisfactory corrosion-resistance qualities and its good mechanical strength at temperatures of up to 200 deg. C. renders it useful for water-cooled cylinder heads, cylinder blocks and similar components.

The magnesium-aluminium casting alloys are among the most resistant to corrosion of all aluminium-base alloys and are used extensively in aeroplane and marine engines. They present difficulties in the foundry, however, these difficulties increasing with the magnesium content. On the other hand, they possess high strength, are readily machinable, and may be treated by the anodic oxidation process further to improve their corrosion resistance. An alloy containing 1 per cent. of magnesium responds to heat treatment and is suitable for the production of sand and gravity die castings of the simpler forms. An alloy containing 4 per cent. of magnesium is employed in the as-cast condition for carburettor bodies, but requires care in casting if successful results are to be obtained. An alloy containing 10 per cent. of magnesium, which is always used in the heat-treated state, shows to the highest degree all the advantages and disadvantages of the aluminium-magnesium group of alloys. Nevertheless, it possesses high impact strength and maximum resistance to sea-water corrosion.

It is stated in the publications that there has been a tendency recently to replace some of the more expensive wrought components of internal-combustion engines by castings in alloys giving the required mechanical properties. As an example, an alloy is cited containing from 4 per cent. to 5 per cent. of copper, a maximum silicon content of 0·9 per cent., a maximum iron content of 0·7 per cent., and a titanium content of 0·25 per cent. This alloy, when chill-cast and suitably heat-treated, is claimed to give a 0·1 per cent. proof stress of 22·5 tons per square inch, an ultimate tensile strength of 26 tons per square inch, and an elongation, presumably on 2 in., of 4 per cent. Moreover, by further heat treatment the alloy can be given a proof stress of 15 tons per square inch and an elongation of 10 per cent. It is used for making pump impellers and oscillating parts.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.

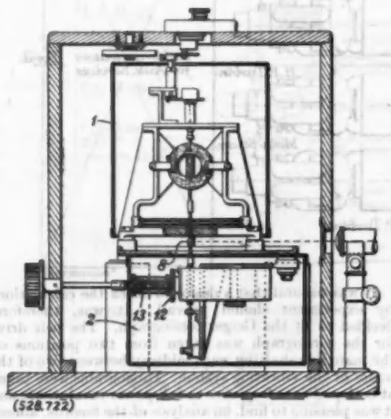
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS.

526,722. Alternating- and Direct-Current Comparator. Elliott Brothers (London), Limited, of Lewisham, G. F. Shotter, of Friern Barnet, and H. D. Hawkes, of New Eltham. (5 *Figs.*) May 13, 1939.—The instrument enables alternating currents, voltages, and powers to be measured in terms of a direct current by a potentiometer and standard cell. It consists essentially of two parts, 1, 2, each part being a moving-coil instrument, mounted one above the other, with their moving coils in the same plane and rigidly secured on a vertical rod supported at its ends by a double taut suspension. The rod carries a small mirror 8 and a pointer. The upper part 1 constitutes a normal dynamometer type of instrument, while the lower part 2 is a direct-current permanent magnet moving-coil type of instrument. Each part is enclosed in a magnetic screening box of Mumetal so as to render it unaffected by external fields. The magnet of the permanent magnet assembly is provided with a variable shunt which can be moved up to or away from the pole pieces by a threaded spindle 13. The torque produced by a given R.M.S. value of alternating current in the dynamometer part 1 is exactly the same as that



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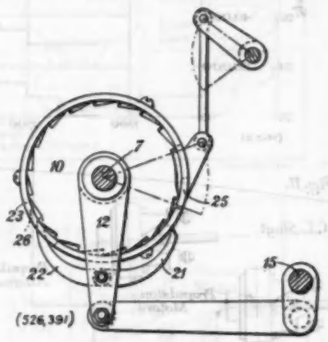
produced by a direct current of the same value. The instrument is primarily intended for use in standardising alternating-current ammeters, voltmeters and wattmeters. For such purposes the instrument is first standardised by connecting the moving coils oppositely in series to a direct-current supply, the fixed coil of the dynamometer part being connected in series with the moving coils. A known value of direct current, say, 50 ma., which is chosen to correspond to the full scale deflection of the instrument under test, is then passed through the instrument, this value being accurately measured by means of a direct-current potentiometer and standard cell connected across a standard resistance in the circuit. The magnetic shunt 12 is then adjusted until the coils take up a zero or null position, which is preferably the position of zero mutual induction between the fixed and moving coils of the dynamometer part 1. The alternating-current circuit is then adjusted until approximately that value of current, voltage, or power is flowing which corresponds to the full scale deflection of the instrument to be tested. The alternating-current and direct-current circuits are then opened, and the dynamometer part 1 and the instrument under test are connected to the alternating-current circuit. Both circuits are then closed, the direct-current circuit is adjusted until a current of 50 ma. is flowing through the moving coil of the direct-current part 2, as measured by the potentiometer in circuit with the standard resistance, and the alternating-current circuit is adjusted until the moving coil system is brought to the zero or null position. The error in the deflection of the instrument under test is then read off. The potentiometer can be calibrated to read directly in terms of the current, voltage, or power in the alternating-current circuit. Temperature errors, and errors due to ageing of permanent magnets, are eliminated by the self-checking feature of the instrument, whereby the control torque is always equalised with the actual torque produced in the dynamometer part. (*Accepted November* 5, 1940.)

FURNACE APPARATUS.

526,391. Feed Control in Automatic Stokers. C. Day, of Mirrlees, Bickerton and Day, Limited., of Stockport. (4 *Figs.*) March 15, 1939.—The stoker is of the underfeed type having a rotatable adjusting nut engaged by a non-rotatable adjusting screw which is connected to the regulating member of a variable-speed gear driving the fuel screw. The nut is rotated by sprocket and chain gear. The spindle 7 of the driving sprocket also carries a ratchet wheel 10 for anti-clockwise rotation and another ratchet wheel for clockwise rotation. An arm 12 is free on the spindle and is connected to the crankpin of a crank-shaft 15 which is driven either from the mechanism which operates the stoker or by an independent motor. The arm carries two spring-loaded pawls 21 and 22 which rotate the ratchet wheels. Engagement with the ratchets is controlled by a ring 23 which is free to oscillate



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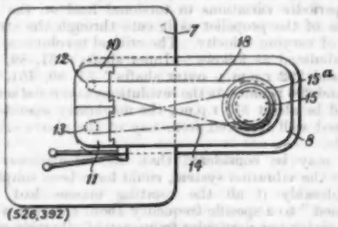
relative to them. The ring has two gaps 25 and 26. In the position shown, the pawl 21 rides on the ring and cannot engage its ratchet, whereas the pawl 22 registers with the gap 26 and can engage and rotate its ratchet. In the other end position of the ring the pawl 22 rides on the ring and the pawl 21 registers with the gap 25 and therefore can engage its ratchet. In the mid-position of the ring neither of the gaps registers sufficiently with the respective pawls to enable either of them to rotate its ratchet. The ring 23 is adjusted by a thermostat in the furnace, or a pressure regulator in the boiler. The transmission ratio of the sprocket wheels and the pitch of the nut are chosen so that the traverse of the screw for the full speed range of the fuel feed is obtained by less than a single complete rotation of the spindle 7. (*Accepted September* 17, 1940.)

MACHINE TOOLS AND MACHINE-SHOP EQUIPMENT.

526,392. Combined Routing and Boring Machine. Thomas Robinson and Son, Limited, of Rochdale, and F. B. Robinson, of Rochdale. (4 *Figs.*) March 15, 1939.—The invention is the embodiment in a single machine of a routing machine having a spindle speed of the order of 20,000 r.p.m., and a recessing and boring machine having a spindle speed of the order of 6,000 r.p.m. The base of the machine supports an adjustable work table 7 and a pillar 8 from which an arm projects over the table. The front face of the arm has two slides, one carrying a



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routing spindle head 10 and the other a recessing and boring spindle head 11, these heads being independently operated. The two spindles each have a long belt pulley 12, 13 to permit vertical travel of the spindle. The recessing and boring spindle is driven by a belt 14 from a pulley 15, while the routing spindle is driven by a belt 18 from a larger pulley 15*a*. The pulleys 15 and 15*a* are driven by separate motors mounted coaxially one above the other, although it would be possible in many cases to use a single motor and suitable clutching mechanism. (*Accepted September* 17, 1940.)